POST-YPRESIAN PLANT REMAINS FROM THE ISLE OF WIGHT AND THE SELSEY PENINSULA, SUSSEX

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POST-YPRESIAN PLANT REMAINS FROM THE ISLE OF WIGHT AND THE SELSEY PENINSULA, SUSSEX

By M. E. J. CHANDLER

SYNOPSIS

The larger geographical features which are the background of post-Ypresian plant life in the Hampshire Basin are indicated. Marine dated deposits in the east of the Basin are seen as related to continental deposits in the west. In the marine beds there is a scarcity of plants, partly no doubt owing to the distance from the land surface on which they grew, partly to the narrow outcrop of the strata. Two marine areas, Whitecliff Bay, Isle of Wight, and Selsey, Sussex, are considered. The former has yielded only one determinable plant up to date, a *Limnocarpus* in Cuisian Beds. The Selsey area with its variable beds and tropical or subtropical fauna has yielded a few species in part at least of Poltavian type. Reference is made to published descriptions of the deposits by Fisher, Reid, Wrigley & Davis and Curry.

INTRODUCTION

In studying the fossil plants of the Hampshire Basin it is helpful to have in mind some general picture of the larger geographical features of the period. In post-Ypresian times evidence of various kinds indicates a continental area to the west with a river system which debouched into a sea lying to the east. Tidal swamps occurred at various points as denoted by beds of *Acrostichum lanzeanum.* They have been found on the present-day coast at Studland and Arne (Dorset), Bournemouth and Hordle (Hampshire).

The massive freshwater Lower Bagshot Beds of Dorset and Middle Bagshot of Dorset and west Hampshire (to use Gardner's familiar terms for the Dorset Pipe-clay Series and Bournemouth Freshwater Beds respectively) and the succeeding brackish estuarine beds with coastal shingle banks of the Bournemouth Marine Series were deposited in the continental region while contemporary marine beds were being formed further to the east. For suggested correlation of the deposits of the two areas by Wrigley & Davis and by Arkell see Chandler (1960*a*, Table on p. 8).

The marine beds are now exposed at the eastern end of the Isle of Wight and in the coast section on both sides of the Selsey peninsula. As might be expected from its position midway between Bournemouth and Sussex the Isle of Wight displays non-marine beds at its western end, well seen at Alum Bay but with a little known flora, and marine beds at its eastern end visible in Whitecliff Bay. Accounts of the fossil plants of the continental western area await publication in a number of monographs and bulletins of the British Museum (Natural History). A consideration of the plant remains of the marine eastern area follows below.

PLANT REMAINS IN THE MARINE BEDS

Although the marine beds were laid down in the sea, or at least at the seaward end of an estuary with marine currents, the land was near enough for plant remains to drift from it to the localities under consideration before they became water-logged to sink and be buried among the marine detritus. Yet it was sufficiently remote for such remains to be scarce. Moreover land mollusca appear so far to be absent altogether while according to Reid (1897 : 8) evidence of only one land mammal has been found. The sparse plant remains include scanty evidence of a true land flora (*Araucarites, Laurocalyx, Wetherellia*) together with estuarine or riparian plants (*Limnocarpus, Caricoidea*) and *Nipa* from tidal mud swamps.

Although so little of the contemporary flora has survived, that little is important because the beds are well dated by marine organisms including *Nummulites* while the range of the strata, Cuisian to Auversian, is wide. In the Isle of Wight younger beds are also exposed but these up to the present have not yielded determinable plant remains although sifting may yet reveal some. It must be borne in mind that the habitats of the plants in both the continental and marine areas are in the same land mass, so that the dated plants of the marine beds represent the impoverished relics of a rich contemporary flora only vaguely dated where found in the continental beds. Possibly in time to come plants from the dated marine area may help in the more exact correlation of the continental plant beds, for although macrofossils are at present few, pollen may yet contribute to this end and additional plant débris of a larger kind may reward persistent search. Hence to stimulate interest in collecting plants from the marine area is most desirable although the limited outcrop of successive horizons at Selsey makes such collecting an arduous task calling for long-term effort.

A. *A Solitary Plant,* Limnocarpus, *in Cuisian Beds at Whitecliff Bay, Isle of Wight*

The Whitecliff Bay section was described in some detail by Fisher (1862 : 65). He numbered successive beds of the Bracklesham Series there with Roman numerals. The section was again examined by Wrigley & Davis (1937 : 205) who used Fisher's Roman numerals on which they superimposed their own Arabic numbering of subdivisions. These Bracklesham Beds include Cuisian, Lutetian and Auversian horizons. At horizon 1 of Fisher Bed IV a solitary endocarp of ?*Limnocarpus forbesi* (Heer) was found by A. G. Davis. It is the only identifiable plant yet found and is the earliest record of a species which, under the name *Limnocarpus headonensis* (Gardner) is abundant in the Bournemouth Marine and later Eocene and Oligocene beds. Fisher Bed IV yields a fauna of Cuisian age including *Nummulites planulatus*. Wrigley & Davis suggested that the Lower Bagshot Beds and the succeeding lowest Bracklesham, Fisher Beds I to III which they regarded as azoic, may be non-marine (1937 : 205, 219). This opinion Mr. Curry writes (personal note) is doubtful because there are moulds of probably marine mollusca in Bed I, and a band of well-rolled flints at its base. It is necessary here to place on record that Mr. Curry has kindly read this manuscript and made many helpful criticisms together with most generous and valuable contributions from his great knowledge of the Bracklesham localities. Wrigley & Davis placed Fisher Bed IV at the top of the Cuisian although they stated that the precise upper limits of this stage are obscure. They suggested that Fisher Bed III, where lignitic seams occur (1937 : 219) may yield plants as some seeds have been found in these seams. Unfortunately these seeds have not been traced.

B. *Plant-bearing Beds of the Selsey Peninsula* (*Cuisian to Auversian*)

The Bracklesham Series at Selsey is very variable and yields a prolific fauna said to be of distinctly more tropical aspect than that of the London Clay. According to Gardner (1882 : 472) the animals are those of a tropical sea which extended south over the Paris-Belgian Basin with southern limits just south of Paris and western perhaps near Evreux. Reid (1897) reiterates the variability of the series with its fauna of tropical and subtropical aspect.

The classic account of the beds by Osmond Fisher is in the same paper as his description of the Whitecliff Bay sequence and there is some comparison and equating (albeit erroneous, Mr. Curry states) of the two localities. Only the horizons which outcrop along the shore between the Bracklesham Bay Hotel and Selsey Bill and again on the east side of the peninsula were known to Fisher who recorded that the lowest beds (i.e. those north-west of the Hotel towards Chichester Harbour) were covered at that time (Fisher, 1862 : 76). The successive horizons which he did examine were denoted by Arabic numerals still in use but he thought, incorrectly it appears, that these beds spanned approximately the same period as the Bracklesham Beds of the Whitecliff Bay section. In 1937 Wrigley & Davis demonstrated that the lower part of the Bracklesham Beds of the Selsey area (those, that is, unknown to Fisher) were of Cuisian age. They succeed the fine-grained marine sediments of the London Clay and were named the Cakeham Beds by Wrigley & Davis who divided them into a Series A below formed of grey quartzose sands equivalent to the Lower Bagshot of Whitecliff Bay and a Series B above formed of sandy clay with a Cuisian fauna including *Nummulites planulatus* and equivalent to Fisher Bed IV of Whitecliff Bay. Fisher himself (1862 : 93) had equated his Bed 1 of Bracklesham with Bed IV of Whitecliff Bay. A recent Excursion Handbook by Curry & Wisden (1958) is of great practical help to anyone studying the Section and gives an excellent up-to-date summary of the successive beds and their positions in the foreshore. It is unnecessary to repeat here details already published by the various workers except as far as may be necessary to explain the age of the plants. As at Whitecliff Bay the Bracklesham Beds include deposits of Cuisian, Lutetian and Auversian age.

The exposures are between tide marks so that collecting is most satisfactory at low water of spring tides as the greatest area is then uncovered (Curry & Wisden, 1958 : 13) but at any time the section or parts of it are liable to be obscured by beach sand to a varying degree. Hence the value of constant observation spread over many years which can best be undertaken by local collectors. By such efforts the brief plant list may yet be considerably augmented. In particular it is important that plants *in situ* should be obtained and Mr. Curry, in searching for other fossils, has already made a start by the discovery of plants in washed residues from carefully specified beds.

PLANTS OF THE SELSEY AREA AND THEIR HORIZONS

Whereas long-drifted wood and twigs are not uncommon, Selsey has so far yielded few genera, species, or even (in most cases) individual examples of a particular plant. The majority of finds have been picked up loose on the beach, probably derived from beds near the spots where they were found e.g. loose fruits of *Nipa* from the Palate Bed (see p. 34). A few specimens have been collected *in situ*. In order to show clearly the horizons which have yielded plants, all found up-to-date are listed in the following Table. The first column shows horizon and locality if known, and the finders of the specimens. The second column gives the names of the plants with brief notes and the B.M. (N.H.) registration numbers of extant material.

CUISIAN	
Cakeham A Beds. Opposite West Wittering Beacon. C. Reid (1897 : 6), Gardner (letter to Reid undated)	*Nipa burtini* (Brongniart) Large carbonaceous "skins" filled with grey quartzose sand (see Wrigley & Davis, 1937 : 215, footnote). Friable, collapse on drying (see p. 33).
A. G. Davis	*Wetherellia* sp. (? *W. dixoni* (Carruthers)) (V.35718). Large carbonaceous coccus mineral impregnated in coarse grey quartzose sandstone crowded with lignitic fragments (see p. 37).
Cakeham B Beds (Marine Phase). East Wittering. D. Curry	*Scirpus lakensis* Chandler (V.29213). Abraded fruit (see p. 33).
LIGNITIC PHASE BETWEEN CUISIAN AND LUTETIAN (*ex lit.* A. G. Davis)	
Equated by Davis with Fisher Bed V of Whitecliff Bay, Isle of Wight. Laminated clays and lignite. *In situ.* East Wittering. A. G. Davis	*Araucarites selseyensis* n. sp. (V.41918, holotype) and slides of cuticle (V. 41918*a–o*). Detached cone-scale on back of same block (see pp. 23, 26).
Grey clay with leaves. *In situ.* East Wittering. A. G. Davis	*Araucarites selseyensis* (V.41919 and slides V.41919*a–l*). Twig and counterpart embedded in clay (see p. 23).
Grey clay, 10–20 yds. east of Bracklesham Lane. *In situ.* M. Goodchild	*Wetherellia dixoni* (Carruthers) (V. 41923). Fruit (see p. 37).
LUTETIAN	
Fisher Bed 2 (*Turritella* Bed). From washings. Bracklesham. D. Curry	?*Wetherellia variabilis* Bowerbank (V. 41886). Small coccus (see p. 39).
Fisher Bed 4 (Palate Bed). *In situ* (*ex lit.* D. Curry) and loose on shore. D. Curry, S. D. & L. T. Garner. Also one fruit recorded C. Reid (1897 : 6) loose near channel from Earnley and *Turritella* Beds, presumed therefore to come from Fisher Bed 4	*Nipa burtini* (Brongniart) (V.29214, V.29215, V.32593, V.40260). Fruits (see p. 34).

Probably Fisher Bed 6. Bracklesham Bay. Ferruginous cemented sand block with lignite, glauconite and *Nummulites laevigatus*. S. D. Garner	*Nipa burtini* (V.33732). Minute, immature fruit and unrecognizable poorly preserved seeds (see p. 34).
Near Fisher Bed 7, loose on shore. Bracklesham Bay. D. Curry	*Laurocalyx* sp. (V.41885). Cupule (see p. 35).
Loose on shore, probably from Fisher Bed 7 or 8 certainly Lutetian. D. Curry	*Nipa burtini* (V.35722, V.35743). Including very large carbonaceous fruits (see p. 35).
Fisher Bed 9 (*Ostrea tenera* Bed). *In situ.* D. Curry	*Carpolithus curryi* n.sp. (V.41887). Pyritized imperfect fruit (see p. 39).

ca. Lutetian-Auversian Boundary

Fisher Bed 11 or 12. Washings of sandy marine clay. D. Curry	*Limnocarpus forbesi* (Heer) (*L. headonensis* (Gardner)) (V.41870–73). Endocarps (see p. 28). *Limnocarpus*(?) *enormis* n.sp. (V. 41874–83). Endocarps (see p. 29). *Caricoidea obscura* Chandler (V.41884). Fruit (see p. 33).

Auversian

Fisher Bed 21 or 22. Opposite Medmery Farm (Medmeney of Dixon, Medmerry of Reid, Medmery of Fisher, Wrigley & Davis) at low water in beds with *Nummulites variolarius*. *In situ.* A. G. Davis. (Equated by Davis with Fisher XVII of Whitecliff Bay, Isle of Wight on field label and in Wrigley & Davis, 1937 : 216)	*Araucarites selseyensis*? (slide V.41921). Twig, totally decayed (see p. 26).
Fisher Bed 21 (Hard Bed). From washings, Selsey. D. Curry	*Carpolithus* sp. (V.41888). Valve of endocarp (see p. 40).
Fisher Bed 21. Selsey. D. Curry	Family Potamogetonaceae, Genus? (V. 41922). Rhizome (see p. 30).

Fairly low in the Series, towards the Middle of Bracklesham Bay (Gardner, 1886 : 4)

Dixon (1850 : 84, pl. 9, fig. 3 ; 1878 : 162)	*Pinus dixoni* (Bowerbank). Holotype (decayed) formerly in Botany Dept. B.M. (N.H.). Cones. (see p. 22).
Gardner (1884, pl. 13, figs. 1, 2, 8)	*Pinus dixoni*. Formerly in Sedgwick Museum, Cambridge (now decayed) (see p. 22).
Dixon (1850 : 84, pl. 9, fig. 4 ; 1878 : 163) Gardner (1884 ; pl. 13, fig. 9)	*Pinus bowerbanki* (Carruthers). Holotype decayed. Cones. Formerly Gardner Coll. decayed (see p. 22).
J. J. B. Ogle. Bracklesham Bay, labelled *Pinites Dixoni* Bowerbank	*Pinus bowerbanki* (V.3313). Cone (see p. 23).

Horizon ?

Small rolled clay pebble on shore. Bracklesham Bay. E. M. Venables. Thought by finder to be Lutetian	*Araucarites selseyensis* (V.41920*a–j*). Twigs now represented by slides (see p. 23). Family Potamogetonaceae, Genus? (V. 41889–41917). Water plant, buds and vegetative fragments (see p. 31).

HORIZON? (Widely distributed loose on beach)	
Loose on shore. Bracklesham Bay. Dixon (1850 : 84, pl. 9, fig. 2)	*Wetherellia dixoni* (Carruthers). Carbonaceous fruits variously distorted (see p. 36). V.40509, holotype. Five-carpelled fruit.
Loose. Thought to be Auversian. E. M. Venables	V.33825–26. Two fruits, one six-carpelled.
Loose. Thought to be Lutetian. Mrs. J. G. Turner	V.33827. Seven-carpelled fruit with spine-bases and casts of hollow spines.
Loose. Thought to be Auversian (Brook Bed). Mrs. J. G. Turner	V.29219. An imperfect fruit. V.29218, V.29220. Two perfect fruits showing casts of hollow spines.
Loose. Picked up nearer the Witterings than Thorney, site of Campanile Bed. Thought to be Cuisian possibly or from beds equivalent to Fisher V of Whitecliff Bay. A. G. Davis	V.32591, V.33828.
Loose on shore. N. A. Pye	V.40259. About 100 fruits scattered over a restricted area of Recent sand probably within the span of Fisher Bed 4 to Fisher Bed 7. (Information from D. Curry.) Much water-worn, very variable in size, laterally compressed.

Apart from the records in the above list there is drifted and teredo-bored wood which lies outside the scope of this paper. It may, however, be noted in passing that coniferous wood and palm wood have both been recorded from Bracklesham Bay. Palm wood from Tertiary beds is also known from Bognor and Worthing (Carruthers *in* Dixon, 1878 : 162–167).

Of the Selsey plants *Araucarites*, *Limnocarpus*, *Caricoidea obscura*, *Nipa*, *Wetherellia* and Lauraceae are typical constituents of the Poltavian flora (cf. Chandler, 1960 : 11). *Pinus* occurs in London Clay, Hengistbury and Barton Beds. *Limnocarpus forbesi* (= *L. headonensis*) is highly characteristic of beds above the Bournemouth Freshwater Beds in Hampshire and the Isle of Wight possibly because it is an estuarine plant. Its absence from the older beds of the Bournemouth area may be due to the lack of estuarine conditions rather than to the non-existence of the species at an earlier period. A record by Gardner (1886 : 400) has now been elucidated. He mentioned that in the higher beds the surface was dotted with *Posidonia* " a marine monocotyledonous plant identical with a species now inhabiting the Mediterranean ". Of this plant no figures were given and few words of description, but a recent discovery (p. 30) appears to indicate the presence of a marine monocotyledon of the family Potamogetonaceae although the generic affinity is not yet clear.

1. WHITECLIFF BAY, ISLE OF WIGHT (CUISIAN BEDS)

ANGIOSPERMAE

Class MONOCOTYLEDONES

Family POTAMOGETONACEAE

Genus *LIMNOCARPUS* C. Reid emend. Reid & Chandler, 1926 : 68

? *Limnocarpus forbesi* (Heer)

(Pl. 7, figs. 20, 21)

For synonyms and history of this species see pp. 28, 29.

DESCRIPTION. *Endocarp* (V.33813): A subglobose internal cast broken at the style so that the hilar end of the enclosed seed projected through the matrix which was a cast of the locule. Germination valve not represented, its form nevertheless clearly defined by the smooth edges of the locule-cast. It arose at the attachment but its exact limits at the upper end were difficult to distinguish because the locule-cast had split in the plane of symmetry at the apex. Maximum breadth of valve, 0·4 mm.; length about 1·3 mm. The internal processes on the carpel wall were partly broken so that the corresponding pits on the cast are not preserved, but sufficient remained to show their original position beneath the exposed hilar end of the seed close to the ventral margin towards which they are directed obliquely downwards. Surface of cast smooth, cells obscure apparently about 0·016 mm. in diameter. External surface of endocarp not preserved. Length of endocarp, slightly incomplete, 1·7 mm.; breadth, 1·3 mm.; thickness, 1·15 mm.

Seed: Solitary, curved, pendulous. Testa thin, surface smooth, shining, cells indistinguishable, hilum indicated by a small truncation on the upper end of the seed.

REMARKS AND AFFINITIES. One specimen belonging to Potamogetonaceae and to the extinct genus *Limnocarpus*. The characters of the external surface are not known, so that whether or not it was rugose cannot be seen, hence the determination is regarded as provisional. The form and size agree with *L. forbesi* (formerly *L. headonensis*). It closely resembles specimens from Bed K, Bartonian of Barton cliff, Hampshire which are similar smooth locule-casts comparable in every respect but in that case the specific identity is confirmed by the presence of abundant rugose carbonaceous endocarps in the adjacent Lower Headon Beds. The older *L. cooperi* Chandler from the Oldhaven Beds (Chandler, 1960*a* : 93, pl. 9, figs. 8–10) is larger than *L. forbesi*. Its surface, unlike the marked rugose surface of *L. forbesi* when complete is only slightly rugose.

2. SELSEY, SUSSEX

GYMNOSPERMAE

Order CONIFERALES

Family Abietineae

Genus *PINUS* Linnaeus

Pinus dixoni (Bowerbank) Gardner

1850 *Pinites dixoni* Bowerbank (in part) *in* Dixon, p. 84, pl. 9, fig. 3.
1878 *Pinites dixoni* Bowerbank : Carruthers *in* Dixon, p. 162.
1884 *Pinus dixoni* (Bowerbank) Gardner, p. 66, pl. 13, figs. 1, 2, 5, 8 ; text-fig. 27.
1960 *Pinus dixoni* (Bowerbank) : Chandler, pp. 202, 220, pl. 29, figs. 12, 13 ; pl. 30, figs. 14, 15 ; pl. 33, figs. 75–79.

The original cone from Bracklesham was said by Gardner to be preserved in the Botany Department of the British Museum although in a very imperfect state. It has now decayed. He reproduced Dixon's figure in his text-fig. 27 (1884 : 67). This cone was said to be 5 in. (*ca.* 126 mm.) long by 1½ in. (*ca.* 38 mm.) broad in the upper part. It agreed closely in size with a cone from the Barton Beds (now decayed) figured and described by Chandler (1960 : 220, pl. 33, figs. 75–79). A smaller cone in the Sedgwick Museum (85 by 40 mm.) figured by Gardner (1884, pl. 13, figs. 1, 2) appears to have been almost identical with a beautiful specimen from Hengistbury (75 by 35 mm.) taken by Chandler as the neotype of the species (1960 : 202, pl. 29, figs. 12, 13 ; pl. 30, figs. 14, 15) (V.36352). The exact horizon of these cones is not recorded (see Table, p. 19). Gardner's cone (1884, pl. 13, fig. 8) was decayed when examined by C. Reid.

Pinus bowerbanki (Carruthers) Gardner

(Pl. 9, fig. 50)

1850 *Pinites dixoni* Bowerbank (in part) *in* Dixon, p. 84, pl. 9, fig. 4.
1878 *Pinites bowerbanki* Carruthers *in* Dixon, p. 163.
1884 *Pinus bowerbanki* (Carruthers) Gardner, p. 68, pl. 13, fig. 9 ; text-fig. 28.
1960 *Pinus bowerbanki* (Carruthers) : Chandler, p. 219, pl. 32, figs. 73, 74.

The species was based by Carruthers on very imperfect material and was therefore ill-defined. It appears that the apophyses were not preserved as is obvious from the figure reproduced by Gardner from the original one (1884, text-fig. 28). A second cone (whereabouts not known, probably decayed) was collected by Gardner himself and figured as *P. bowerbanki* (Gardner, 1884, pl. 13, fig. 9). It was about 100 mm. long, 50 mm. broad with apophyses of the scales having a recurved umbo and marked transverse carina. A cone from Barton, imperfect length, 85 mm. ; breadth between 20 and 40 mm., probably belongs to the same species. It was described by Chandler (1960 : 219, pl. 32, figs. 73, 74). Whether these two are really identical with the original mutilated cone cannot now be decided, but since there were two *Pinus* species at Bracklesham, it seems best to retain the name *P. bowerbanki* for these larger cones with sharply carinated apophyses and recurved umbos rather than to introduce another specific name.

A cone (V.3313) purchased from J. J. B. Ogle, 1891, labelled *Pinites Dixoni* Bowerbank, Bracklesham Bay appears to belong to this species. It is imperfect below, 130 mm. long as preserved, with maximum breadth (80 mm. from apex) of about 65 mm. The apophyses are markedly elongate transversely, the largest about 22 by 5 mm.; they are sharply carinate with conspicuous recurved umbo.

Family ARAUCARINEAE

Genus ***ARAUCARITES*** Presl.

Araucarites selseyensis n. sp.

(Pl. 4, figs. 1–5; Pl. 5; Pl. 6)

?1850 *Lycopodites squamatus* Brongn.: Dixon, p. 84, pl. 9, fig. 1.

DIAGNOSIS. Some twigs with broad short spreading leaves, others with narrow acicular leaves. Leaves amphistomatous, the dorsal stomatal bands being restricted in the broader leaves to the lower end and to a small patch or line of stomata (sometimes one stoma only) separated from the main band by a distinct area of ordinary epidermal cells. Sometimes in acicular leaves dorsal stomata absent in the upper half of the leaf, sometimes represented by a narrow line of stomata extending almost to leaf tip. Ventral stomatal bands in all types of leaf extending throughout the length. Many stomata on both surfaces transversely oriented in the broader leaves but some longitudinal or oblique. On the acicular leaves all stomatal bands narrow, the majority of their stomata being longitudinally aligned. Ordinary epidermal cells with numerous small oval pits, commonly rectangular, sometimes slightly narrowed towards their extremities. Cone-scale subquadrangular, broadest at about two-thirds of the length from the base, apex with long parallel-sided process having rounded distal end.

HOLOTYPE. A twig with broad leaves embedded in small clay block (about 45 to 50 mm. in diameter) on back of which is detached cone-scale. Brit. Mus. (N.H.), No. V.41918.

DESCRIPTION. *Twigs:* Varying in habit with broad spreading leaves as in the holotype (Pl. 4, fig. 1) or narrow acicular leaves as in Pl. 5, fig. 7. A twig showing both types of leaves was macerated in order to obtain leaves for cuticle preparation (cf. Pl. 6, fig. 13 and slides V.41920*a–j*). Leaves in all twigs falcate, spirally arranged, sharply pointed, decurrent, normally four-sided, the sides or facets often unequal. Broader leaves often with a wide angle over the midrib on the ventral surface, while some of the lateral leaves may be distorted. In some leaves distortion in growth so great as to produce a bifacial effect. V.41918 is about 25 mm. long with leaves which may measure about 5 mm. from the tip to the point where they spring away from the twig on the dorsal side. V.41919, represented by counterparts, has a more slender appearance and is about 35 mm. long with leaves about 6 or 7 mm. measured as in V.41918 above. The length and narrowness of the leaves on this twig produce much narrower facets but a few broader more spreading leaves were exposed at the base of the twig after the figure in Pl. 5, fig. 7 had been taken. Carbonaceous substance was preserved in all specimens together with impressions in clay but as it was much cracked cuticle preparation was difficult. In particular the dorsal cuticle was cracked and brittle and broke up when mounted permanently after preliminary examination. Yet enough fragments remain to demonstrate some of the outstanding features. All leaves amphistomatous, the stomata being concentrated in well-defined stomatal bands.

Upper surface: Stomatal bands always extend from base to apex but do not merge at the apex in the examples seen. They narrow upwards so that whereas near the base there may be as many as nine longitudinal lines of stomata, near the apex these are reduced to one or two lines per band. Sometimes many stomata in a line are contiguous, eight to ten such having been counted (slides V.41918 *a*, *b*, V.41920*c*). Adjacent lines may also be contiguous but auxiliary cells are never shared either in the same line or in adjacent lines. The stomatal bands are inevitably narrower in the long narrow leaves of V.41919 (cf. also slides V.41919*a*, V.41920*b*). Some of these narrower leaves show only two lines of stomata, or even one, in a band ; others show three or four lines always reduced to one towards the apex. On the decurrent basal flange (V.41918*c*, *e*) there may be two or three lines of oblique stomata above, but one only at the extreme base. In this decurrent region in the broad leaves the cells appear somewhat larger than in the free part of the ventral surface. On the whole in the broad leaves transversely oriented stomata predominate (Pl. 6, figs. 14, 16, 17) although oblique and longitudinally oriented ones also occur. The asymmetry of a leaf may however result in one stomatal band having transverse stomata and the other oblique (slides V.41918*a–c*, *e*, V.41920*c*). Again the band on the broader of two facets in an asymmetrically developed leaf may have more lines of stomata than that on the narrower facet. In the acicular leaves stomata are more frequently longitudinally oriented but transverse and oblique ones may occur. They vary in size, usually being larger on the broader leaves. The outer pore, where measured, ranges from 0·027 to 0·04 mm. There are from four to six auxiliary cells arranged end to end around the pore and these cells are normally differentiated into polar and lateral. There is also commonly a regular outer ring of concentric cells. In the broader leaves the breadth of the auxiliary cells combined with their transparency and the manner in which they sweep around the stomata make the apparati conspicuous as light coloured oval to subcircular patches in the cuticle. Occasionally ordinary epidermal cells are so arranged as to produce three concentric rings in parts of a stomatal apparatus. Where the guard cells abut on the auxiliaries a pair of thick scales is present or there may be a ring of cuticle (Pl. 6, figs. 15, 17). The ordinary epidermal cells of the stomatal bands are often quite irregular in shape and frequently equiaxial. However several transversely elongate and aligned cells commonly occur between adjacent stomata in the same longitudinal row as well as elsewhere sometimes. The three bands of ordinary epidermal cells outside the stomatal bands naturally tend to be wider in the broader than in the acicular leaves, the cells themselves also being broader. In the marginal bands of the broad leaves the two outermost lines of cells are aligned obliquely. In one leaf examined six to ten rows of cells were visible in the marginal bands ; in another there were twenty to twenty-six rows. The median band of ordinary epidermal cells also varies greatly in width, twenty to thirty-eight rows of cells having been counted. These epidermal cells are commonly rectangular in broad leaves and in all leaves are straight-sided not sinuous. They become shorter towards the junction with the twig and may here be equiaxial or even transversely elongate and aligned. In acicular leaves they tend to be relatively narrow and are sometimes narrowed towards their extremities (Pl. 5, fig. 8 ; cf. also slides V.41919*a*, *k*, V.41920*g*). Small oval or subcircular pits irregular in size and distribution are scattered over the cell walls in all leaves (Pl. 6, figs. 15, 19).

Lower surface: The cuticle is somewhat denser with narrower and smaller cells (slides V.41918*f*, V.41920*a*) this character being most marked in acicular leaves (Pl. 5, figs. 9, 10 ; cf. slides V.41919*c*, V.41920*b*, *g*). The stomatal bands, unlike those of the upper surface are almost restricted to the base of the leaf in the broader leaves, sometimes extending for a short distance only onto the free outstanding part (slide V.41918*f*) in other cases occurring only on the decurrent part (slides V.41918*a*, *b*). Hence they always terminate a long way below the corresponding ventral stomatal bands (Pl. 4, fig. 2). Sometimes, however, a few stomata (three were seen in slide V.41918*f* but the tip of this leaf later became disorganized on permanent mounting,) or a short line of stomata are present nearer the apex separated from the main stomatal band by a distinct area of ordinary epidermal cells. In slide V.41918*a* a single isolated stoma occurred in this position (Pl. 4, fig. 2). It is not possible on the amount of material seen to state that these separated patches of stomata are always present, further evidence is needed. In the acicular leaves there may be a long stomata-free tip (Pl. 5, fig. 10) but an asymmetrically developed leaf in slide V.41920*a* (Pl. 5, fig. 9) shows a single line of stomata at the distal end of the leaf surrounded by dense narrow epidermal cells. In this latter case it has not been possible to ascertain whether this line is separated from the main stomatal band below as only the upper half of the leaf was preserved. In the broad leaves seen the stomatal bands may have seven to nine longitudinal lines of stomata at the base the number decreasing upwards. Invariably individual stomata and lines of stomata are more widely spaced than on the upper surface. Frequently two lines have four or six lines of ordinary epidermal cells between them (V.41918*b*, *k*, Pl. 6, figs. 18, 19) which form conspicuous " lanes " in the stomatal band. In these " lanes " the cells are usually rectangular and longitudinally aligned. A few stomata may occur quite close to the margin of a leaf on the narrow decurrent basal region in the middle of ordinary epidermal cells. In the acicular leaves two lines of stomata are common but four to five lines have been seen (V.41919*f*, *i*). Stomata in the broad leaves are oblique or transverse, sometimes longitudinal (V.41918*c*, *d*, *k*) but transverse and longitudinal stomata occur in a single leaf. In the acicular leaves the stomata are commonly oblique or longitudinal and frequently contiguous. As on the ventral surface scales or a ring of cuticle are present at the junction of guard cells and auxiliaries and there is the same stomatal structure but on the whole the stomata tend to be smaller. Pits are conspicuous on the walls of the ordinary epidermal cells in both types of leaf. At least two fragments from a decurrent leaf base showed pits with two concentric rings like bordered pits. In the broad leaves the median band of ordinary epidermal cells displays a variable number of cell rows, eight being seen in one leaf, twenty in another. These cells are most commonly rectangular. In the acicular leaves they are long and narrow with a more noticeable tendency to narrow towards their ends.

A stout twig with acicular curved leaves is figured in Pl. 5, fig. 12. The leaves were angled on both surfaces, the angle on the upper surface being inconspicuous, that on the lower clearly marked as were the lateral angles also. Unfortunately this twig has completely decayed and a mere scrap of cuticle showing the ordinary epidermal cells of the median band was obtained (V.41921). While therefore it probably belonged to the same species as the other twigs this awaits confirmation from further material from horizon Fisher 21 or 22.

It is highly probable, as suggested by Gardner (1883 : 59) that *Lycopodites squamatus* Brongn. (Dixon, 1850, pl. 9, fig. 1) was also an *Araucarites* twig, but as the relationship of the new material either to Brongniart's species or Dixon's specimen cannot be established this specific name has not been adopted.

Female cone-scale (Pl. 4, figs. 3–5) : The detached cone-scale (V.41918) is subquadrangular in outline, broadest at about three-quarters of the length from the base where there are two lateral angles of about 90°. Below this line of greatest breadth the scale is contracted to the basal attachment. Above it the sides converge more rapidly to the apex. At the apex there is an attenuated subparallel-sided process with rounded distal end and slight median ridge on its upper surface. The external apophysis of the scale lies above the line of greatest breadth. It can be seen on the impression to the left in Pl. 4, figs 3, 4 where exposed by the flaking away of the carbonaceous substance. It shows as a marked facet separated by a distinct ridge from the conspicuous longitudinally striate limb of the scale. A less prominent transverse ridge on the upper surface of the carbonaceous scale has flutings, rounded upwards, which are visible on the right in Pl. 4, figs. 4, 5 where the actual substance of the scale is preserved. This substance has cracked on drying along the flutings. Possibly this fluted ridge represents a ligule. Below the ridge (or ligule) the upper surface shows two or three rows of large rounded closely contiguous pits producing a regular pattern for a short distance. Further down the limb there are rectangular cells (larger than those in an *Araucarites* scale from the Upper Headon of Colwell awaiting description). They give rise to longitudinal striations coarser than the ones in a corresponding position on the lower surface of the scale. In addition there are more conspicuous longitudinal rounded ridges and grooves giving rise to flutings due to thick resin ducts in the wall of the scale. The ducts lie opposite to and alternating with the apices of the rounded flutings of the ridge and are from 0·2 to 0·4 mm. apart. On drying the resin swelled, rupturing the thin tissues which originally covered the ducts so that solidified resin was thereby exposed. Two small matrix-filled apertures are seen on the upper surface just below the base of the terminal process (Pl. 4, fig. 5) which appear to lead into canals. A longitudinal section at right angles to the breadth exposed by the rupture, through drying, of the carbonaceous scale revealed a small cavity indicated superficially by a slight median convexity. It extended only for a short distance down the scale. A second smaller cavity with a transversely striate lining layer lay behind it in the thickness of the scale. The significance of these cavities is not clear. No seed seen. Length of scale including apical process, 16 mm.; maximum breadth, 11 mm.; length from tip of spine to line of greatest breadth, 7 mm.; length of limb below line of greatest breadth, 9 mm.; length of spine, 4 mm.

Remarks and affinities. The association of female cone-scales similar to the one described above with foliage of *Araucarites* type at Bembridge (Pl. 4, fig. 6), Selsey and Célas (Alais basin, France) points to a connexion between scales and foliage confirmed by actual organic continuity in the Célas material described by Marion as *Doliostrobus* (1888 : 1–20, pls. 1, 2). The scale from Bracklesham Bay has therefore been referred with the associated foliage to *Araucarites selseyensis*. Despite differences of habit shown by the foliage the cuticle structure appears to indicate that the twigs belong to a single species. This is distinguished in the best preserved broad leaves from the more or less contemporary *Araucarites* in the Bournemouth Beds by the restriction of the stomata on the dorsal surface to a stomatal band at the base of the leaf with sometimes a small area, separated from the main band, nearer the leaf tip as described above. In the Bournemouth species the dorsal stomatal bands extend throughout the length of the leaf ending only a short distance below those of the ventral surface. *A. selseyensis* is also distinguished by the more regular rectangular ordinary epidermal cells particularly in the broader leaves, with their clearly defined irregularly scattered pits. Also a larger proportion of the stomata are transversely oriented. A fragment of cuticle from Bournemouth has been described by Bandulska (1923 : 248, pl. 20, figs. 13, 14) and more awaits publication in a monograph of the Bournemouth Flora.

The distribution of the dorsal stomata also distinguishes *A. selseyensis* from *A. gurnardi* Florin from the Bembridge Beds, Isle of Wight (*in* Reid & Chandler, 1926 : 48) where again the dorsal stomatal bands extend almost throughout the length of the leaf. However the ordinary epidermal cells of *A. gurnardi* more nearly resemble those of *A. selseyensis* in being rectangular-ended and conspicuously pitted.

An Australian species of probable Oligocene age described by Cookson & Duigan (1951 : 428, pl. 3, figs. 19–24) and actually referred to the genus *Araucaria* itself as *A. lignitica* shows a somewhat similar distribution of stomata which the authors point out is found in seven living species of *Araucaria* of the section Eutacta. In this case the characters of the female cone, seed and male cones confirm the relationship.

As regards the scale of *A. selseyensis* it appears quite distinct from the Bembridge scales (Pl. 4, fig. 6, also Reid & Chandler, 1926 : 52, pl. 2, figs. 17, 18) and from a Colwell Upper Headon scale mentioned above on account of its narrower, more attenuated form, possibly also on account of the long apical process which may however be incomplete in the Bembridge and Colwell material. The cone-scales of the Bournemouth *Araucarites* are not known. There is a close resemblance between the scale of *A. selseyensis* and those of Marion's *Doliostrobus Sternbergii*. Both have a similar cuneate form with steep-sided apex and long apical process. *Doliostrobus* is known to show great variation in scale size in accordance with the position in the cone e.g. one scale was 17 mm. long, 12 mm. broad and the distance from the tip of the spine to the line of maximum breadth was 10 mm. The largest scale depicted was about 18–20 mm. long (including the spine), the smallest 8 mm. A consistent difference lies in the sharply pointed tip of the spine of *Doliostrobus* as against the rounded tip of *A. selseyensis*. No leaf cuticle structure is known in the case of *Doliostrobus*.

The cuticle, form of foliage, and scale with long process in the Selsey material indicate Araucarian affinities, but more information is needed as regards the cone-scales and seed structure before it can be referred to the living genus *Araucaria*. Hence the reference to the conventional genus *Araucarites* as *A. selseyensis*.

ANGIOSPERMAE

Class MONOCOTYLEDONES

Family Potamogetonaceae

Genus ***LIMNOCARPUS*** C. Reid emend. Reid & Chandler, 1926 : 68

Limnocarpus forbesi (Heer)

(Pl. 7, figs. 22–24)

1862 *Cyperites Forbesii* Heer, p. 373, pl. 18, figs. 20, 21.
1888 *Cyperites forbesii* Heer : Gardner, p. 422, pl. 3, fig. 16.
1888 *Carpolithes headonensis* Gardner, pp. 420, 423, pl. 3, fig. 30.
1898 *Limnocarpus headonensis* (Gardner) C. Reid, p. 464, text-fig. p. 465.
1925 *Limnocarpus headonensis* (Gardner) : Chandler, p. 13, pl. 1, figs. 4*a–c*, text-fig. 3.
1926 *Limnocarpus headonensis* (Gardner) : Reid & Chandler, p. 70, pl. 4, figs. 1–3.
1960 *Limnocarpus headonensis* (Gardner) : Chandler, pp. 205, 222, pl. 30, figs. 16, 17 ; pl. 33 figs. 84–86.

Description. *Endocarp:* Subovoid with large deep pit on each broad surface at about one-third of the length of the endocarp from the apex (Pl. 7, figs. 22, 24). Style long, patent, slightly reflexed at apex when perfect (Pl. 7, fig. 23), terminal on the ventral margin. Short stalk persistent. Germination valve narrow-ovate arising near the stalk but not reaching the style base, with three strong longitudinal ridges one median and two marginal. Lateral ridges only slightly tubercled. Broad surfaces rugose and pitted, the pits formed by the merging of adjacent rugosities. Length of endocarp, 1·75 mm. including style (about 0·25 mm.) ; breadth, 1·25–1·3 mm. ; thickness, about 1 mm. A smaller abraded endocarp measured : length, 1·5 mm. ; breadth, 1 mm. ; thickness, 0·75 mm.

Remarks. The species is represented by three figured and five unfigured (V.41873) specimens. They agree with the species hitherto referred to *L. headonensis* (Gardner). It occurs in the Lower Headon of Hordle and the Bembridge Beds as well as in the Hengistbury and Barton Beds. There are unpublished records in the Lower and Upper Headon of Colwell Bay, Isle of Wight and in the Bournemouth Marine Beds. The occurrence of the endocarps in enormous quantities in estuarine beds e.g. in the *Limnocarpus* Band at Hordle, indicates a gregarious habit probably in brackish lagoons or quiet backwaters. Reid & Chandler (1926 : 71) expressed the opinion that fruits named *Cyperites forbesi* by Heer (1862 : 373, pl. 18, figs. 20, 21) were probably crushed specimens of *L. headonensis* (as it was then named) but as no extant material of *C. forbesi* was known and Heer's figures and description were inadequate the suggestion could not be confirmed. Recently a hand specimen (No. 6712) labelled *Cyperites forbesi* Heer full of crushed *Limnocarpus* has been seen in the Geological Survey Museum where Heer's specimens from Hamstead are preserved. It is believed to be Heer's figured specimen (1862, pl. 18, figs. 20, 21) and is so labelled with a query. Other fruits (No. 76921) similarly labelled *C. forbesi* (Burdett Coutts collection) confirm this relationship. Hence under the rules of nomenclature *Limnocarpus headonensis* must now be referred to *L. forbesi* (Heer) since the genus *Cyperites* was first created by Lindley & Hutton for Cyperaceae leaves and was subsequently used by Heer for *all* remains of Cyperaceae of unknown generic affinity. *Limnocarpus* is definitely referred to Potamogetonaceae and is therefore retained as the generic name of this species.

Limnocarpus? enormis n. sp.

(Pl. 7, figs. 25–33)

DIAGNOSIS. Endocarp ovoid with large scattered tubercles. Style long straight, ventral margin with conspicuous rounded ridge. Internal condyle short associated with a small inconspicuous comma-shaped depression on each side of the ventral edge at about one-third of the length from the apex. Keel with three longitudinal tubercled ridges having also a few scattered tubercles on the surface between the ridges. Size very variable. Length (including style) about 2·5–3·5 mm.; breadth, 1·75–2·5 mm.; thickness, 1·5–2 mm.

HOLOTYPE. V.41874.

DESCRIPTION. *Endocarp:* Ovoid (frequently somewhat flattened in fossilization) with long patent style more or less terminal on the ventral margin and slightly forwardly directed. Ventral margin with a conspicuous longitudinal rounded ridge. Broad surfaces with large scattered rounded tubercles conspicuous in unworn specimens (Pl. 7, figs. 25, 30) but scarcely seen in worn ones (Pl. 7, figs. 26, 28). Keel (germination valve) ovate, broad, arising near the basal attachment but not extending to the base of the style having three conspicuous longitudinal ridges, one median and two marginal bearing a few low rounded tubercles. A few scattered tubercles also lie between the ridges (Pl. 7, figs. 27, 32, 33). Lateral pits differing from those of *Limnocarpus forbesi* in being very inconspicuous, long and narrow, comma-shaped close to the ventral ridge arising not far below the style base and directed towards the ridge narrowing downwards. Sometimes they are indicated only by a line of close-set tubercles externally (Pl. 7, figs. 29, 30). Internally these pits are associated with only a small process on the locule wall (Pl. 7, fig. 31). External surface of obscure equiaxial cells. Seed not preserved but from the character of the locule it can have been only slightly emarginate near the hilum around the small process and with a large lower and small upper limb. Locule lining of small equiaxial cells with large cavities. Dimensions very variable. The following are examples: 1) Length (including 1 mm. long style), 3·5 mm.; breadth, 2 mm.; thickness, 2 mm. Valve or keel missing extending to 0·3 mm. from style base. 2) Length (including style, 1 mm.), 3·25 mm.; breadth, ·2 mm.; thickness, 1·5 mm. Keel missing, endocarp collapsed below. Lateral pits begin at approximately 0·5 mm. from style base and extend for about 1 mm. (Pl. 7, fig. 26). 3) Length (including style, 0·5 mm.), 2·5 mm.; breadth, 1·75 mm.; thickness, 1·6 mm. Keel preserved. 4) Length (style missing), 2·5 mm.; breadth, 1·75 mm.; thickness, 1·75 mm. Keel missing. 5) Detached keels *ca.* 2–2·5 mm. long, 1·2 mm. broad. 6) Length of style in broken endocarp, 1 mm. Length of endocarp incomplete. Breadth, 2·5 mm. Foramen indicated by flanking tubercles (Pl. 7, fig. 30).

REMARKS. Represented by seven endocarps (some imperfect), two detached keels and three fragments. They appear to differ from the genus *Potamogeton* and from *Limnocarpus forbesi* in the less curved seed-cavity and from *Ruppia* in the gently curved ventral margin which is unlike the gibbous margin of that genus and in the keel arising near the peduncle. Although the resemblance is greatest to *Limnocarpus* the fruits are referred to it only doubtfully as there may be other genera as yet unknown to the writer which are more comparable. From all the fossil species of Potamogetonaceae previously described it is distinguished by its large size and the closeness of the comma-shaped inconspicuous lateral pits to the ventral margin. There is no evidence as to whether the low tubercles scattered over the surface were originally spines.

Genus?

(Pl. 8, fig. 38)

DESCRIPTION. *Rhizome:* Repeatedly branched with close-set nodes and long narrow transversely elongate and oriented leaf-scars which do not completely encircle the stem but appear to embrace about half its circumference. One leaf-scar underlies each node but it is not clear whether there are additional scars between the nodes. The scars show traces of several bundle fibres. The branches arise in the axils of the leaves. One branch *a* (Pl. 8, fig. 38) is seen on the right at the base (as preserved) and extends for about 28 mm. before it is broken at the edge of the stone. At its point of origin it is very small but it broadens rapidly upwards to 6 mm. in diameter. Its exposed upper surface shows at least six leaf-scars and the cut transverse end of another branch on the right at *b* (Pl. 8, fig. 38) close to its origin. The main stem is visible for a short distance only as it is broken above the second node. It bears another branch *c* (Pl. 8, fig. 38) on the left in the axil of a conspicuous leaf-scar. About 6 mm. of this branch is preserved before it reaches the edge of the stone where it is about 5 mm. broad. A small circular funnel at one node may indicate the point of emergence of another branch now broken. No roots have been seen but these, if present would lie on the lower surface of the rhizome and be concealed by matrix. The leaf scars project, each internode gradually increasing in diameter upwards so that the rhizome has a distinctive jointed appearance. Surface covered by a thick shining somewhat dimpled epidermis which is formed of small square or rectangular cells about 0·008–0·009 mm. in diameter. The slightly thickened lateral walls of these cells give a fine longitudinally striate appearance and on drying the epidermis and rhizome tend to crack along the striae. Inside the stem there are traces of large air-cells or cavities varying much in size, the largest being about 0·027 mm. in diameter. Subglobular pyrites casts sometimes occupy their cavities and are conspicuous when the carbonaceous walls have decayed.

Leaf: A detached parallel-sided fragment of an elongate leaf *l* (Pl. 8, fig. 38) lies athwart the lower end of the specimen but almost certainly belongs to it as indicated by its identical epidermal structure. The tip (seen on left) is blunt and rounded. The width is 2 mm. but only about 13 mm. of the length are preserved. There are traces of several parallel longitudinal nerves.

Remarks. This unique specimen, found by Curry in Fisher Bed 21 at Selsey, suggests at a first glance rhizomes radiating from a centre although closer examination shows repeated branching at successive levels. The jointed stem with large leaf-scars is highly characteristic of certain marine genera of Potamogetonaceae such as *Posidonia* and *Cymadocea*. Gardner (1886 : 400) reported that the surface of one of the Bracklesham Beds was " dotted over " with " *Posidonia* " but added that " the rhizomes radiate from a centre, whilst in the French and other European fossil species they are long and branching ". It appears highly probable that V.41922 is a rhizome of the supposed " *Posidonia* ". The living *Posidonia* has close-set leaf-scars and a jointed rhizome thickly clothed with shredded remains of leaves reduced to bast fibres. *Cymadocea* shows similar features. The generic relationship cannot be regarded as finally established and the possibility that these rhizomes may belong to one of the species of the extinct *Limnocarpus* found in the Bracklesham Beds of this area cannot be excluded. It does at least seem clear that it represents a genus of Potamogetonaceae with jointed rhizomes. Whether there is a connexion with the branches and buds of Genus? (see Pl. 7, figs. 35–37 ; Pl. 8, figs. 39–48) is again purely a matter for speculation on evidence at present available.

Family Potamogetonaceae?

Genus?

(Pl. 7, figs. 35–37 ; Pl. 8, figs. 39–48)

Description. Buds or bulbils preserved in two different ways giving different appearances. Some, seen from the side, are oval or oboval in outline, originally ovoid but compressed in fossilization, truncated at the base by a large slightly sunk attachment scar now ellipsoidal originally subcircular. From the edges of the scar can be traced overlapping three or four stiff rather pointed bud-scales or bracts with irregularly toothed upper margins. The scales are represented by casts of their inner surfaces with traces only of organic substance. They are seen in V.41895–96, V.41902, V.41907, V.41909 (cf. Pl. 8, figs. 43, 45). Others, the most numerous, are usually larger and inflated, subglobular and they show very clearly the basal sunk circular attachment scar with punctations marking points of entry of a number of fibro-vascular bundles. These clearly represent internal casts of the external scales, the growing point and inner scales having presumably decayed, their place being taken by a mud-cast of the globular cavity thus formed. Such mud-casts are preserved in V 41889–94, V.41900 (cf. Pl. 7, figs. 35–37, Pl. 8, figs. 39–45). In V.41890 (Pl. 7, fig. 36) and V.41897, scales still remain adhering to the mud, the former specimen also showing the internal mud-casts last described still adhering to the scales. In V.41902 near the basal scar thin-walled areoles, about 0·038 mm. in diameter are visible in small patches, each areole being occupied by minute equiaxial convex rounded cells, also seen in V.41895. These cell patches represent organic tissues still adhering to the casts or their impressions. Obscure longitudinal striation is seen in V.41894 and V.41895 suggesting veins although no actual fibres are preserved. Certain of the buds show an asymmetric development as in V.41891 and V.41897 (Pl. 7, fig. 37 ; Pl. 8, fig. 46) probably indicating that they have begun to grow out laterally. A further stage of growth is seen in V.41899 (Pl. 8, fig. 48). Buds arise at the nodes of a puckered or flanged stem fragment (V.41890, Pl. 7, fig. 36) but sometimes from a flatter more ribbon-like stem (V.41892 ; and Pl. 8, fig. 39). They may be solitary and alternate or several may be associated at one level. The stems retain remains of carbonaceous tissues and show the impressions of thin-walled cells about 0·038 mm. in diameter like those on the bracts (V.41889, V.41892). There is also obscure evidence of flat ribbon-like finely longitudinally striate leaves always very imperfect. One arises from a node in V.41889 (cf. Pl. 7, fig. 35). Occasionally when the globular internal casts are broken from the stems a deep cup-like hollow is exposed with circular cavity at its base. It is surrounded by puckered remains of scales (V.41901). In V.41889 basal scales are well seen with the bud-cast in profile projecting from between them. This cast also has fine concentric puckerings on its surface suggesting that the surrounding bracts (now gone) had a diaphanous thin lining. Dimensions vary considerably according to the stage of development. Examples of the subglobular casts are : 1) Length, 3 mm. ; breadth, 2·5 mm. 2) Length, 2·75 mm. ; breadth, 3·25 mm. 3) Length, 1·6 mm. ; breadth, 1·7 mm. 4) Length, 1·6 mm. ; breadth, 2·16 mm. Diameter of basal scar, 1·25–2 mm. Transverse diameter of dorsiventral flattened detached casts, 2·5 by 2·5 mm. ; 2·4 by 2·4 mm. Examples of the laterally flattened ovoid buds are : 1) Length, 2·16 mm. ; breadth, 1·1 mm. 2) Length, 3·2 mm. ; breadth, 2 mm. 3) Length, 3 mm. ; breadth, 2 mm.

Remarks and affinities. Twenty-nine specimens (V.41889–V.41917) show obscure fragments of stem and leaf with buds (or bulbils) connected with propagation or the formation of lateral branches. All were derived from the small rolled clay pebble which yielded an *Araucarites* twig with cuticle (see p. 19). The evidence for a water plant lies in the character of the large thin-walled areoles or cells. The possible indications of parallel longitudinal nerves suggest Monocotyledones. The buds with circular attachment scar could belong to Cyperaceae, Gramineae or Potamogetonaceae, but scales with denticulate margins appear to exclude relationship with the two first-named families so far as these could be examined. The specimen is referred tentatively to Potamogetonaceae but the genus cannot at present be determined. There is as yet no evidence to connect these fragments with *Limnocarpus* which also occurs in the Bracklesham Beds of the Selsey area.

Family Cyperaceae

Genus *SCIRPUS* (Linnaeus)

Scirpus lakensis Chandler

1960 *Scirpus lakensis* Chandler, p. 206, pl. 30, fig. 26.

The apical end of a characteristic fruit showing the contraction at the style. Only the inner yellow shining translucent integument is preserved but it shows clearly the characteristic longitudinal ridges and transversely elongate hexagonal cells.

Genus *CARICOIDEA* Chandler, 1957 : 86

Caricoidea obscura Chandler

(Pl. 7, fig. 34)

1960 *Caricoidea obscura* Chandler, pp. 207, 223, pl. 30, figs. 27–33, 34? ; pl. 33, figs. 98–105.

Description. A typical fruit, subovoid in outline, truncated below by a large foramen which marks the attachment, rounded at the stylar end. The surface is much abraded but shows the corky wall formed of small equiaxial cells. Length of fruit, 1·75 mm. ; breadth, 1·25 mm. ; breadth of (flattened) basal truncation, 0·5 mm.

Remarks. The holotype of this species is from Cliff End, near Mudeford. The species also occurs in the Lower Bagshot and Bournemouth Freshwater and Marine Beds.

Family Nipaceae

Genus *NIPA* Thunberg

Nipa burtini (Brongniart)

(Pl. 9, fig. 49 ; Pl. 10, figs. 51–53)

1894 *Nipadites Burtini* (Brongniart) : Rendle, pp. 147–150, pl. 6.
1897 *Nipadites Burtini* (Brongniart) : C. Reid, pp. 6, 7, fig. 11.
1960*a* *Nipa burtini* (Brongniart) : Chandler, p. 133, pl. 14, figs. 4–9.

Undoubted large drifted fruits of *Nipa burtini* " about the size of a coconut " were obtained by Clement Reid from Cakeham Beds A and many had been seen earlier by Gardner. One specimen figured by Reid (1897, fig. 11) had previously been figured by Rendle, natural size (1894, pl. 6). When efforts were made to preserve it, it began to break up but remains showing the grey quartzose matrix were formerly in the British Museum (Natural History). As in the case of the Boscombe *Nipa* fruits the preservation made it difficult to keep them for long. The carbonized sand-filled hulls were liable to crumble on being taken from the damp beach while the carbon films cracked and peeled, hence it may be assumed that such specimens would not drift intact far from the beds in which they lay. The published figures show a longitudinally angled fruit, incomplete at the base, umbonate at the apex, typical of *N. burtini*, and about 13 cm. long, 11 cm. broad. An undated letter from Gardner to Clement Reid states " the Bracklesham fruits [Nipas] are always the same size and nearly as large as the Belgian ones ". Gardner added that it was years since he had found one at Bracklesham and he thought that the beds had since been covered up. Curry records (1958 : 15) that the Cakeham Sandstone with fruits of *Nipa* has not recently been seen.

Two smaller very differently preserved pyritized *Nipa* fruits found loose on the shore by S. Garner are figured (Pl. 10, figs. 51, 52). They show marked differences in size and development and resemble the Sheppey specimens in their preservation. Mr. Curry (*ex. lit.*) reports that they are probably from the Palate Bed (Fisher 4) which has fairly frequently been exposed in recent years, he himself having found similar pyritized fruits *in situ* at this horizon as well as loose on the shore (V.32593) in the neighbourhood of this bed. V.29214 is a small flattened oboval immature fruit, slightly imperfect at the extreme base. Its surface is longitudinally angled and smooth and evidently represents the epicarp. Obscure, ill-preserved, oblong, longitudinally aligned cells are seen. Length of fruit (as preserved), 5·8 cm. ; maximum diameter, 3·6 cm. ; diameter at right angles to this, 1·5 cm. V.40260 is a fragment, 6·7 cm. long, 5 cm. broad, of a much better developed fruit showing part of the fibrous sarcocarp ; when complete this fruit must have been at least 10 cm. long and 6 cm. broad but the breadth is imperfect and the apex much broken. The outer layers are worn so that at the lower end part of the margin of the foramen for germination is visible. Impressions of the stout longitudinal fibres of the sarcocarp are seen all over the surface but the parenchyma cells between them are obscure. There are no details of seed structure on the ill-preserved concave inner side of this fragment but its form and the size of the concavity on the reverse side suggest that it once contained a well-developed seed. A third fruit incomplete at base and apex, 38 mm. broad was found by L. Garner (V. 29215) in the same sort of position.

Reid (1897 : 6) describes the finding of a single *Nipa* close to the *Turritella* Beds and to the channel that runs from Earnley (i.e. near the outcrop of the Palate Bed). Although this fruit is no longer extant and its mode of preservation is not described the locality suggests derivation from the Palate Bed especially as the carbonaceous sand-filled shells from Cakeham would be unlikely to survive transport for such a distance.

One extremely small immature much ribbed fruit (V.33732) is almost certainly of Lutetian age (communication from Mr. Curry) as the loose block of matrix in which it was found is full of *Nummulites laevigatus* which only occurs abundantly in Fisher Bed 6, a bed of which only small areas have been seen while its lower part is decalcified and weathered and buried under Pleistocene and Holocene mud. The lower end of the small fruit is buried in the matrix, the length must have been about 10 mm. ; maximum breadth, 4·5 mm. The surface at the upper exposed end shows a film-like layer of rounded equiaxial cells about 0·028–0·038 mm. in diameter exactly comparable with cells seen at the upper end of living *Nipa* both in mature and immature specimens. Lower down the fruit, Recent and fossil, the superficial cells become somewhat elongate and longitudinally aligned giving rise to longitudinal striations.

A collection of at least seven very perishable fruits (V.35743) was made by Mr. Curry in an area of about 50 square yards on the surface of the Eocene clay eastwards of Bracklesham. The condition of the specimens was such that they could not have travelled far and Mr. Curry considered that they were probably from Fisher Bed 7 or 8 and must certainly in any case be Lutetian. The largest specimen (V.35722) is shown in Pl. 9, fig. 49; it was about 19 or 20 cm. long and about 11 cm. broad. Another long narrow fruit, slightly imperfect at the apex, was about 15 by 6 cm. Other specimens were mere fragments of the broadest part of the fruits they represented.

A noticeable feature of this batch of specimens is that one side only is preserved; on the reverse side is matrix with, or without, embedded fragments of fruit. Some specimens are overlain by an incrustation of pyritized sand which may mask them almost completely. The matrix in all cases is a somewhat glauconitic quartz sand bound by ferruginous cement and the whole specimen is brittle. The carbonaceous substance of the fruits shows, when fresh, the striate surface and long narrow cells of the smooth epicarp in the middle and lower regions, and underneath this are the coarse fibres (conspicuous) and parenchyma (obscure and much pyritized) of the sarcocarp. These tissues are compressed and have become very thin. They quickly disintegrate by cracking into rectangular fragments.

Class DICOTYLEDONES

Family Lauraceae

Genus *LAUROCALYX* Reid & Chandler, 1933 : 219

Laurocalyx sp.

(Pl. 10, figs. 54, 55)

Description. *Cupule* (V.41885): Broadly obconical (now somewhat flattened in fossilization), rather abruptly narrowed into the thick peduncle, smooth rimmed without sepals. Thick walled. Surface wrinkled and puckered, conspicuous longitudinal wrinkles occur in the lower half and are continued on to the stalk, while equally marked transverse wrinkles are seen at the rim of the cupule and parallel with its margin. Fine irregular convex more or less equiaxial puckerings of varying shape are found all over the surface. Surface cells very obscure, but apparently originally convex and equiaxial, about 0·013–0·018 mm. in diameter. These cells are now almost obliterated by the stresses due to crushing which may have produced narrow parallel bands variously oriented and having close parallel striae at right angles to the length. Some of the rounded convexities of the surface suggest the presence beneath them of secreting glands. No berry was preserved but the scar of attachment of the fallen berry is seen in the base as a dull unpolished area, presumably it was originally circular, now, through compression, 10 by 4 mm. in diameter. Length of cupule including stalk, 18 mm.; transverse diameter as crushed, 20 by 6 mm. (probably originally about 15 or 16 by the same).

REMARKS AND AFFINITIES. It is impossible to tell the generic relationship of this empty cupule but clearly it belongs to the family Lauraceae. It is most probably derived from the Lutetian horizon (Fisher Bed 7) near to which Mr. Curry found it.

Family EUPHORBIACEAE?

Genus ***WETHERELLIA*** Bowerbank emend. Reid & Chandler, 1933 : 251

Wetherellia dixoni (Carruthers)

(Pl. 10, figs. 56–63 ; Pl. 11, figs. 64, 65)

1850 *Cucumites variabilis* Dixon (non Bowerbank), p. 84, pl. 9, fig. 2.
1850 " Undetermined fossils " Dixon, pl. 12, fig. 20.
1878 *Carpolithes Dixoni* Carruthers *in* Dixon, p. 164, pl. 9, fig. 2 ; pl. 12, fig. 20.
1954 *Wetherellia dixoni* (Carruthers) Chandler, p. 173.

EMENDED DIAGNOSIS. Fruit a loculicidal and septicidal syncarpous capsule, originally subglobular but somewhat dorsiventrally depressed, beset externally with hollow spines. Carpels so far seen four to at least eight, locules and septa marked by longitudinal external ribs or angles. Seeds usually shorter in proportion to their breadth than those of *W. variabilis* Bowerbank. Length of fruit (frequently distorted), 4–16 mm.; breadth, 13–20 mm. Seeds (much distorted), length, 3·7–7 mm.; breadth, 1·4–4·75 mm.; thickness, 1–1·5 mm.

HOLOTYPE. A five-carpelled syncarpous subglobular capsule falling into segments along loculicidal and septicidal planes of dehiscence. Surface showing spine-bases. Seeds shorter in proportion to the breadth than in *W. variabilis*. Brit. Mus. (N.H.), No. 40509.

DESCRIPTION. Originally spiny with spine-bases or internal casts of hollow spines alone remaining (V.29218, V.29220, V.33827 and 40509). Syncarpous with from four to at least eight radially arranged carpels (possibly more). Carpels often unequally developed at the opposite ends of a transverse diameter giving the fruits a lop-sided arrangement (Pl. 11, fig. 64). Subglobular but usually somewhat dorsiventrally compressed, the compression much increased by fossilization, occasionally laterally compressed (40259). Longitudinal ribs or angles correspond with the locules and septa, so that there are at least eight to sixteen longitudinal ribs. Dehiscence both septicidal and loculicidal (Pl. 10, figs. 56, 58). Axis fibrous giving off coarse branching fibres which pass more or less transversely across the septal walls of the cocci to the exterior of the fruit. These fibres, and others in the thickness of the pericarp apparently terminated in external spines (Pl. 10, figs. 57, 59) which were hollow as indicated by thin shining pyrites internal casts (V.33827) and especially abundant in the furrows between the ribs and angles. Locules extending almost from base to apex of the fruit, and from the axis almost to the periphery, so much compressed tangentially as to be flat except for a narrow inflated area occupied by the seed. The seeds are solitary in the locules, pendulous, suspended by long arched funicles (about 2 mm. in length) from a point on the axis about one-sixth to two-sevenths of the length of the fruit from the apex. They lie somewhat obliquely in the locules so that the distal end is nearer to the axis than the proximal end. Locule lining formed of cells, 0·01 mm. in diameter, aligned so as to produce a general appearance of radial striation. The walls between the locules are thick, formed of coarse equiaxial angular cells, but the structure is often obscured by carbonization which causes the fractured surfaces to appear vitreous and structureless. Dimensions of several fruits, all more or less dorsiventrally compressed or otherwise distorted : 1) Length (holotype), 7 mm. along axis ; diameter, 13·5 mm. 2) (V.33825) Length, 4 mm. ; diameter, 15 mm. Dimensions of some laterally crushed fruits which therefore show maximum length (V.40259) : 1) Length, 16 mm. ; diameter, 20 mm. 2) Length, 11 mm. ; diameter, 17 mm. 3) Length, 14 mm. ; diameter, 14 mm. Some small abortive fruits (V.40259) with minute flat immature seeds measured about 10–12 mm. in both length and diameter. See also V.33827 and V.41923 with abortive seeds.

Seed : Oval or elongate-oval, anatropous, narrowed towards the hilum, chalaza at the broader extremity. Testa thin, formed of a single layer of equiaxial polygonal or quadrangular cells, 0·025 mm. in diameter. Dimensions of much distorted seeds : 1) Length, 4·7 mm. ; breadth, 1·4 mm. 2) Length, 3·3 mm. ; breadth, 3·3 mm. 3) Length, 5·5 mm. ; breadth, 4 mm. ; thickness, 1 mm. 4) Length, 7 mm. ; breadth, 4·75 mm. ; thickness, 1·5 mm.

Remarks and affinities. The most abundant plant fossil of the Selsey shore represented in the British Museum (Natural History) alone by well over a hundred specimens. The horizon or horizons from which these fruits are derived is unknown except in the case of V.41923 from Bracklesham Beds, foreshore at Bracklesham at low-tide mark about twenty yards east of Bracklesham Lane end (probably equivalent to the top of Fisher Bed V at Whitecliff Bay—Cuisian?). They are carbonaceous and unlike *W. variabilis* relatively thin-walled and very light in weight and therefore capable of being drifted along the shore by tides and currents.

The generic position of these fruits is clear. The genus *Wetherellia* was placed tentatively in the family Euphorbiaceae for reasons given by Chandler (1954 : 175). The Bracklesham fruits appear to belong to a distinctive species, for up to the present there is no evidence of external spines in *W. variabilis*, the locules of which vary in number from two to five (four to eight at least in *W. dixoni*), the walls appear thicker and its fruits are therefore less liable to distortion, the external angles and ribs are less marked, the seeds relatively longer in proportion to their breadth, while the dehiscence is commonly septicidal first and later loculicidal.

Wetherellia sp. (***? W. dixoni***)

(Pl. 11, figs. 66–68)

Description. *Fruit :* Originally two-loculed, ellipsoid or subovoid but now represented by a single one-loculed semiellipsoid coccus which has resulted from the septicidal splitting of the fruit. Ventral surface flat, dorsal rounded. A median longitudinal suture on both faces indicates the plane of the locule but loculicidal dehiscence has been prevented by the infiltration of mineral cement. Remains of the axial fibres are seen along the suture line on the septicidal inner surface. From the axis one distinct fibre is given off on its right side which is directed radially for a short distance, it then forks, the lower fork quickly disappearing into the thickness of the wall, the other curving upwards and giving off subsidiary branches which also penetrate the wall. Carpel thick and woody with indications of coarse equiaxial parenchymatous cells. Locule lining close-textured seen in section but its surface cells not visible. External surface of coccus slightly rugose owing to a few scattered spine or hair-bases forming short protuberances with a central hollow now filled with matrix or calcite. Length of coccus (slightly broken at apex), 21 mm. Estimated complete length about 30 mm. ; breadth, 24 mm. ; thickness in plane of locule, 10 mm. Seed not seen.

REMARKS. The specimen is a mineral impregnated carbonaceous coccus together with its concave external mould preserved in a coarse-grained grey sandstone block full of lignite fragments from Cakeham Beds A. Owing to the coarseness of the matrix and the mineralization of the specimen fine details of structure are somewhat obscure, but there is indubitable evidence of hair-bases both on the coccus and its cast. The large size of the specimen is a striking feature. The coccus fits the cast exactly so that no shrinking has occurred probably owing to infiltration of mineral matter into the carbonaceous substance. The complete length of about 30 mm. is in excess of a rare maximum of 26 mm. in *Wetherellia variabilis* Bowerbank (20 mm. is the published maximum) and 16 (allowing for distortion) or possibly 20 mm. in *W. dixoni*. It is necessary in making comparison to remember that *W. variabilis* from the London Clay is always much pyritized, the cells being distended by infiltration of pyrites, hence the measurements given represent the maximum known for that species. On the other hand *W. dixoni*, is carbonaceous, relatively unpyritized and usually much crushed and may easily have shrunk to half or one-third of its original dimensions. On these grounds the Cakeham fossil more resembles *W. dixoni* than *W. variabilis*. The poorly preserved evidence of external spines also recalls *W. dixoni*. Against this relationship are two facts, first, that the specimen was clearly two-loculed when perfect and this character is seen in specimens of *W. variabilis* but not as yet in *W. dixoni* ; second, that as in *W. variabilis* the conspicuous or primary splitting has been septicidal, whereas in *W. dixoni* it is frequently loculicidal. It is possible to account for this latter fact by early infiltration of calcite into a primary incipient loculicidal fissure which on crystallizing acted as a cement or in the case of *W. variabilis* from the London Clay by infiltration of pyrites, but if so it is curious that the cementing should have occurred in the loculicidal planes rather than between the closely adpressed septicidal surfaces. While awaiting fresh evidence it seems advisable to refer the specimen to *Wetherellia* sp. (*W. dixoni*?) bearing in mind the possibility that a distinct species may be represented, or that *W. variabilis* and *W. dixoni* will prove to be inseparable given a sufficiently large range of material showing varying types of preservation.

? ***Wetherellia variabilis*** Bowerbank

(Pl. 11, fig. 69)

1840 *Wetherellia variabilis* Bowerbank (pars), p. 84, pl. 12, figs. 1–5, 8–40.
1933 *Wetherellia variabilis* Bowerbank : Reid & Chandler, p. 251, pl. 9, figs. 7–22.

A small coccus, flattened on the inner septicidal surface, angled on the outer face, along the plane of loculicidal splitting, and elliptical in outline was washed by Mr. Curry from the *Turritella* Bed (see Table, p. 18). Loculicidal splitting has started. Typical coarse angular parenchyma is seen in the thickness of the wall. Length, 16 mm. ; breadth, 6 mm. ; dorsiventral thickness, 4 mm.

The specimen from the Lower Lutetian had collapsed on drying but was repaired by Mr. Curry.

The flat ventral surface of the coccus suggests a two-carpelled fruit. The walls appear thick and there are no traces of external spines, but the specimen is in poor condition and they would probably not show even if present. While clearly a coccus of *Wetherellia* the specific relationship is doubtful but the characters recall *W. variabilis* rather than *W. dixoni*.

Incertae Sedis

Carpolithus curryi n. sp.

(Pl. 11, figs. 70, 71)

Diagnosis. Fruit probably inferior with accrescent perianth, gamosepalous below, divided? at the apex. A syncarpous, three-loculed, loculicidal capsule, obovoid, many-seeded with axile placentation. Seeds probably in two rows in each locule borne horizontally, pointed at the hilar end, rounded at the distal end, curved? Length of fruit, 10·5 mm. ; estimated transverse diameter, 7 mm.

Holotype. V.41887.

Description. *Fruit:* Probably inferior with accrescent perianth, gamosepalous below, possibly dividing into free broad perianth segments at the apex of the fruit and if so segments alternating with the locules and reaching to the extreme tip of the fruit. Surface much abraded, cell structure obscure. Fruit a syncarpous capsule, approximately obovoid with three slightly unequally developed loculicidal locules indicated by lobes with a median longitudinal line of dehiscence. Surface of fruit finely striate transversely, formed of small transversely aligned cells. Placentation axile on projecting placentas. Shallow transverse furrows on the external surface of a perfect carpel indicate numerous horizontal seeds piled one upon the other probably in two rows. These impressed outlines have a slight sigmoidal curve upwards towards the plane of dehiscence. The seeds must have been narrow and pointed at the hilar end, rounded at the distal end and flattened on their contiguous surfaces, and the form suggests a curved cavity or embryo. Length of fruit, 10·5 mm. ; estimated transverse diameter, 7 mm.

REMARKS. One pyritized fruit from Fisher Bed 9 with embedded sand and glauconite. It shows the perianth on one side, imperfect at the apex but suggesting a free lobe alternating with two of the locules. The upper end of one locule with seed impressions is well displayed and the ventral side of another is exposed by the loss of the dorsal wall revealing projecting axile placentas. The relationship has not been discovered but the fruit would be recognizable if found again so that a specific name, *Carpolithus curryi*, in honour of the finder has been given. It is possible that it may belong to the Monocotyledones or to Theaceae but without further evidence of seed characters no closer determination is possible.

Carpolithus sp.

(Pl. 11, figs. 72, 73)

One valve of a bisymmetric endocarp, much abraded. Obovate in outline probably with an organ at the narrow obliquely truncate end but the internal surface is too decayed to show details of the cells and their direction. Externally the margin at the broad end shows a few coarse teeth and the lateral margins show radial striations due to the alignment of obscure ill-preserved cells. A raised obovate area occupies most of the external surface but leaves a broad rim on the right. The raised area is ornamented by a rounded sigmoidal ridge which becomes thin and sharp near the base. Cell structure is obscure but a few equiaxial pits about 0·038 mm. are visible. Length of valve, 3·5 mm.; breadth, 2·8 mm.; thickness (i.e. of half fruit), 1 mm. The relationship has not been traced.

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PLATE 4

Araucarites selseyensis n. sp.

FIG. 1. Holotype. Twig showing broad spreading sometimes laterally flattened leaves. × 2·7. (V.41918.)

FIG. 2. Part of the ventral and dorsal cuticle of a leaf from the above. The dorsal cuticle shows the tip free of stomata except for a solitary stoma separated by a belt of ordinary epidermal cells from the main left stomatal band. The leaf has been completed by a diagram based on slide V.41918*a* when perfect. *v*1 and *v*2 the two halves of the ventral cuticle split longitudinally show stomatal bands, *sb*, extending to the leaf tip. *d*1 and *d*2 are the main dorsal stomatal bands. × 50.

FIG. 3. Cone scale, upper surface with apica lprocess buried in matrix, on back of holotype. × 2·5.

FIG. 4. Same after process, *p*, was fully exposed. Impression of lower surface here exposed by collapse of scale substance. × 2·5.

FIG. 5. Distal end of same. × 6·5.

From laminated clays and lignite equal to Fisher Bed V of Whitecliff Bay (undated lignitic phase between Cuisian and Lutetian); East Wittering.

Doliostrobus sp. (*Araucarites gurnardi* Florin)

FIG. 6. Scale for comparison. Apical process broken or buried, note greater breadth of scale. × 2. (V.17514.) Bembridge Beds ; Gurnard Bay, Isle of Wight.

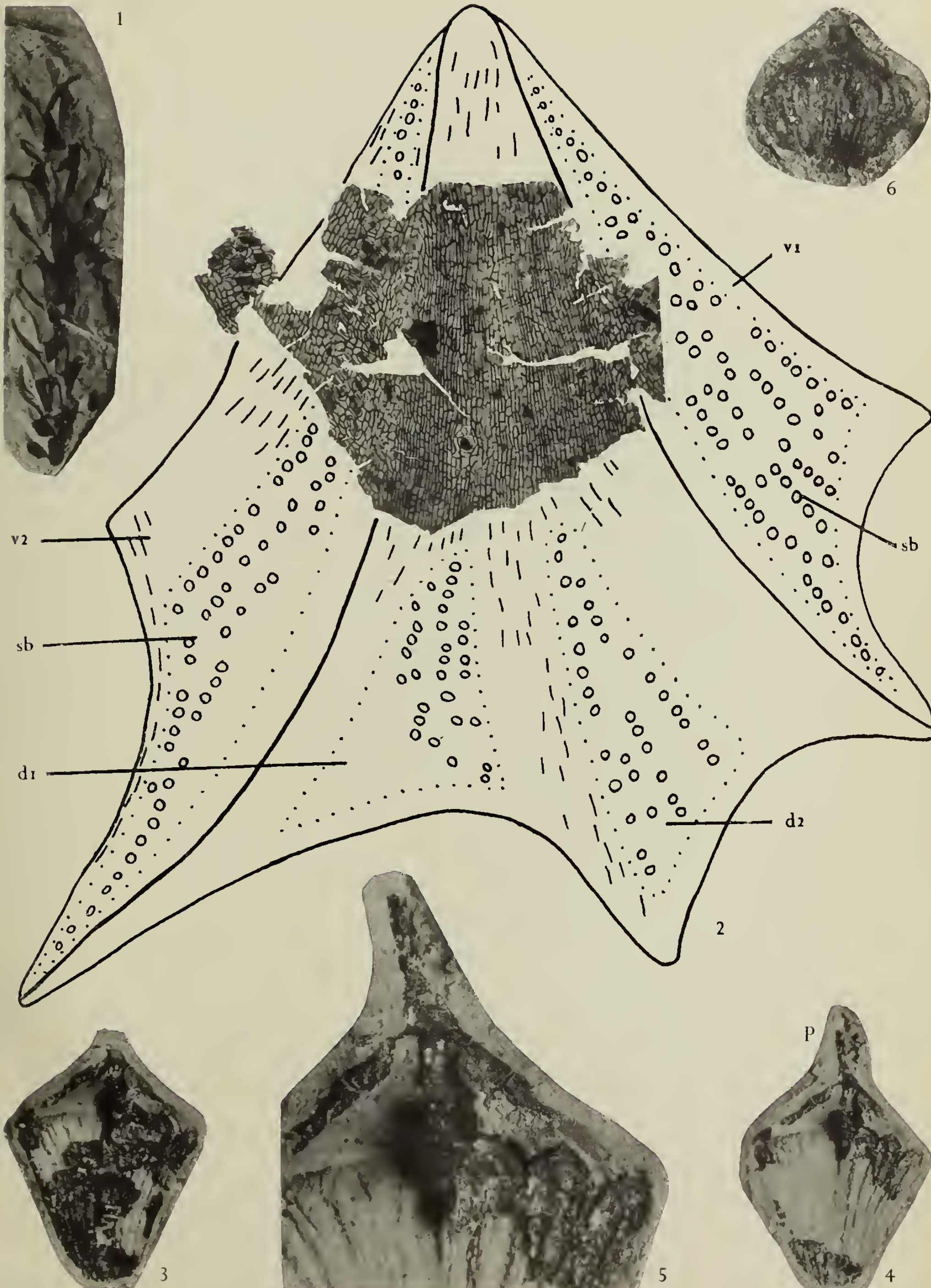

1
6
v1
v2
sb
sb
d1
d2
2
P
3
5
4

PLATE 5

Araucarites selseyensis n. sp.

FIG. 7. Twig, one of a pair of counterparts showing acicular leaves. $\times 2 \cdot 7$. (V.41919.)

FIG. 8. Part of ventral cuticle of a leaf from the above near leaf tip showing narrow stomatal band, *sb* ; *m*, the median band of ordinary epidermal cells. $\times 50$. (V.41919*a*.)

From grey clay (undated lignitic phase between Cuisian and Lutetian) ; East Wittering.

FIG. 9. Tip of a leaf from a twig in Pl. 6, fig. 13. *l*, is the sharp lateral margin ; *m*, obscure median angle on dorsal surface flanked by unequal facets. Thinner ventral cuticle with broader stomatal band is seen at *v*, *v*. Denser dorsal cuticle at *d*, *d*. A line of stomata, *ds*, is seen on one dorsal facet. There is no evidence to show whether it was continuous with the dorsal stomatal band below. $\times 50$. (V.41920*a*.)

FIG. 10. Distal end of leaf cuticle from same twig ; *v*, *v*, ventral cuticle with stomatal band ; *l*, lateral angle of leaf between ventral and dorsal, *d*, cuticles ; *m*, median angle of dorsal surface flanked by ordinary epidermal cells without stomata. $\times 50$. (V.41920*b*.)

FIG. 11. Ventral cuticle of a broad leaf from same twig near junction, *j*, with twig. It shows the broad median band, *m*, of ordinary epidermal cells and one broad stomatal band. Still attached is part of the dorsal cuticle, *d*. Stomata are present on this surface only below the level of the free leaf tip. $\times 50$. (V.41920*c*.)

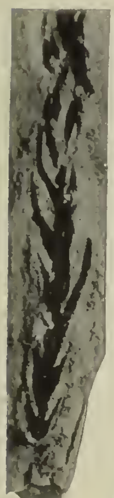
Horizon? In rolled clay pebble thought to be Lutetian ; Bracklesham Bay.

FIG. 12. A larger twig with spreading acicular leaves probably this species. (Now disintegrated.) $\times 1 \cdot 8$. Fisher Bed 21 or 22, opposite Medmerry Farm in beds with *Nummulites variolarius* (Auversian).

9


12

10


7

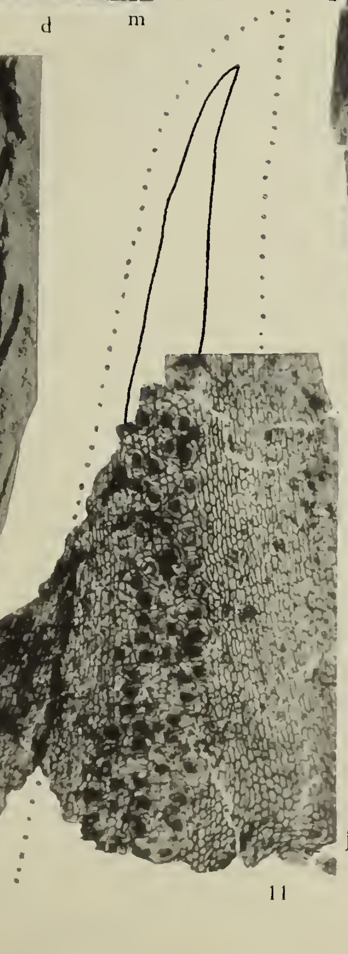


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PLATE 6

Araucarites selseyensis n. sp.

Fig. 13. Twig from which cuticles of broad and acicular leaves have been prepared. (Now disintegrated and represented by slides V.41920*a–j*.) Horizon? × 2. From rolled block thought to be Lutetian ; Bracklesham Bay.

Fig. 14. Right side of ventral cuticle near junction with twig, *j* ; *s*, stomatal band. × 50. (V.41918*b*.)

Fig. 15. Part of same to show stomata. The ordinary epidermal cells of the median band, *m*, show pits as rounded shadows. × 100. (V.41918*a*.)

Fig. 16. Part of left ventral stomatal band of another leaf. Distortion in growth causes the stomata to be obliquely oriented. × 100 approx. (V.41918*c*.)

Fig. 17. Part of right stomatal band of same leaf with less obliquely distorted stomata. × 200 approx.

Fig. 18. Dorsal cuticle from decurrent basal part of leaf showing broad " lanes " of ordinary epidermal cells between lines of stomata. × 100. (V.41918*c*.)

Fig. 19. Part of same cuticle showing details of stomata and pits in epidermal cells. × 200 approx.

From laminated clays and lignite (undated lignitic phase between Cuisian and Lutetian) ; East Wittering.

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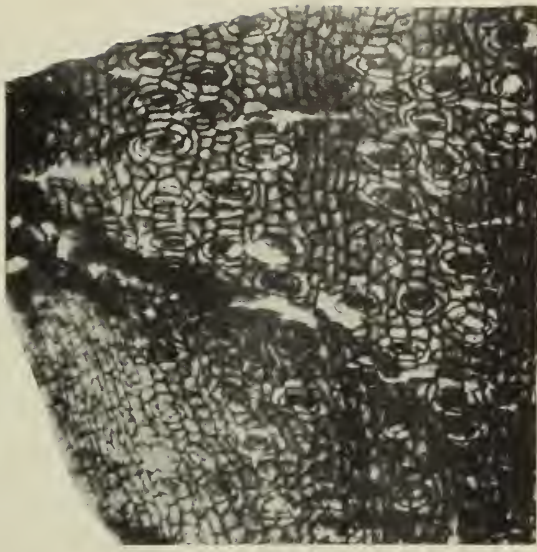

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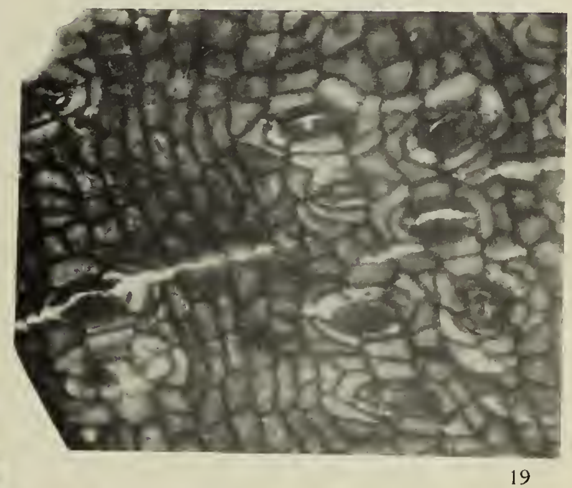

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PLATE 7

Limnocarpus forbesi (Heer)

Fig. 20. Locule cast, side. *s*, projecting hilar end of seed. Germination valve on left. ×15. (V.33813.)

Fig. 21. Same, dorsiventral view, showing gaping aperture left by the germination valve. ×15.

From Cuisian (Lower Bracklesham) ; Whitecliff Bay, Isle of Wight.

Fig. 22. Carbonaceous endocarp, side, showing *st*, style (imperfect) ; *a*, attachment and *f*, the conspicuous lateral foramen. ×15. (V.41870.)

Fig. 23. Another showing complete recurved style, *st*. Valve is in shadow at *v*. ×15. (V.41871.)

Fig. 24. A smaller endocarp. ×15. (V.41872.)

From Fisher Bed 11 or 12 (Lutetian-Auversian boundary) ; Bracklesham Bay.

Limnocarpus ? enormis n. sp.

Fig. 25. Holotype. Large endocarp with long style and tubercled surface. Gaping aperture, *k*, for fallen valve is in shadow. Long lateral foramen, *f*, is obscurely seen. ×15. (V.41874.)

Fig. 26. Another somewhat distorted endocarp, *a*, attachment. Aperture for valve at *k*, elongate lateral foramen at *f*. ×15. (V.41875.)

Fig. 27. A smaller endocarp, dorsilateral, with broad ridged valve. ×15. (V.41876.)

Fig. 28. Same, ventral, showing ridge and long style. ×15.

Fig. 29. Another with broken style, ventral. The lateral foramina flanking the ventral ridge at *f* are partly concealed by associated tubercles. ×15. (V.41877.)

Fig. 30. A very large endocarp, imperfect below. Lateral foramina concealed by tubercles are at *f*. ×15. (V.41878.)

Fig. 31. Interior of one half showing oblique ridge of condyle, *c*, corresponding with external foramina. Broken below. ×15. (V.41879.)

Fig. 32. A detached valve, side. ×15. (V.41880.)

Fig. 33. Another, dorsal. ×15. (V.41881.)

From Fisher Bed 11 or 12 (Lutetian-Auversian boundary) ; Bracklesham Bay.

Caricoidea obscura Chandler

Fig. 34. Fruit, side showing base truncated by hilar opening. ×15. (V.41884.) Fisher Bed 11 or 12 (Lutetian-Auversian boundary) ; Bracklesham Bay.

Potamogetonaceae? Genus?

Fig. 35. Stem lying in matrix with leaf at node. Also internal cast of bud, *b*. *br*, a ring of bracts from which a bud has fallen. ×6·5. (V.41889.)

Fig. 36. Much puckered stem bearing clay internal casts of buds at *b*, *bb*. Basal scars are clear and an embracing bract is seen above *bb*. ×6·5. (V.41890.)

Fig. 37. Internal cast of a large bud with basal scar on right below. Two obliquely oriented stem fragments are seen above and below the bud. ×6·5. (V.41891.)

Horizon? Rolled block with *Araucarites* twig (V.41920) thought to be Lutetian ; Bracklesham Bay.

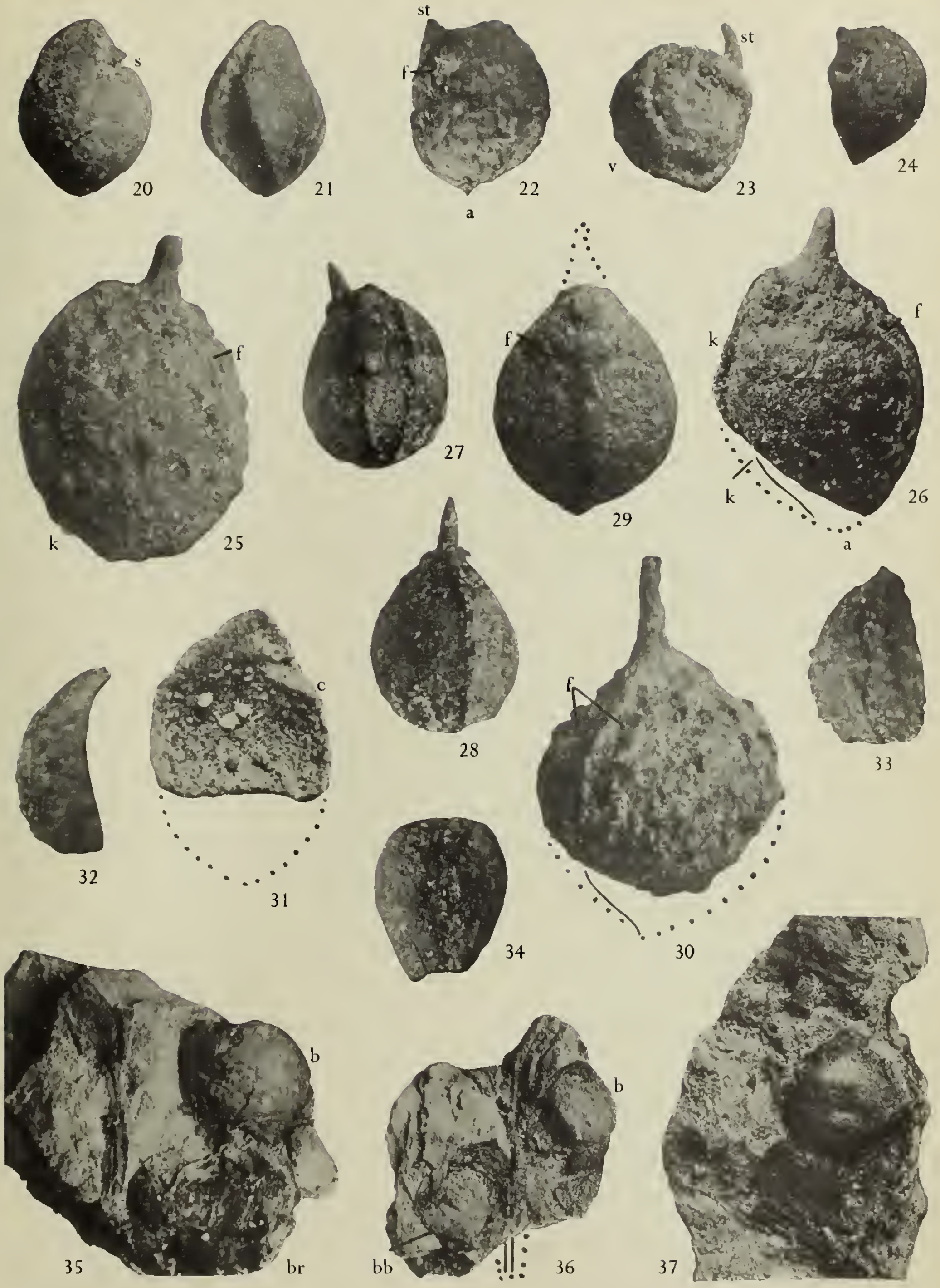
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PLATE 8

POTAMOGETONACEAE Genus ?

FIG. 38. Branched jointed rhizome, *a*, *b*, *c*, indicate branches. ×3. (V.41922.) Fisher Bed 21 (Auversian) ; Selsey.

POTAMOGETONACEAE? Genus?

FIG. 39. Striate stem showing two nodes with buds, *b*, of varying size, some still attached. Another stem with a bud lies on the extreme left of clay fragment. Persistent scales, *sc*, once surrounded a bud (now gone). ×6·5. (V.41892.)

FIG. 40. Internal cast of detached bud showing large circular attachment scar. Impressions of overlapping scales are seen on sides beyond the scar. ×6·5. (V.41893.)

FIG. 41. Another bud cast tilted to show basal scar. Fine longitudinal striae diverge from scar over sides. ×6·5. (V.41894.)

FIG. 42. Opposite end of same showing collapsed condition at apex. ×6·5.

FIG. 43. Another bud cast, side. Striate lateral surfaces are seen. Attachment scar is obscurely visible in profile at base. ×15. (V.41895.)

FIG. 44. A distorted bud showing rounded attachment scar and at the margins the serrate edges of scales in profile. ×15. (V.41896.)

FIG. 45. Same, opposite side showing serrate edge of a scale lying obliquely. ×15.

FIG. 46. External impression of a bud, side still surrounded by carbonaceous scales. A fragment of longitudinally striate stem is seen below. ×6·5. (V.41897.)

FIG. 47. Internal cast of a bud, *b*, side, lying in a hollow in clay still flanked at base by carbonaceous scales, *s*. × 6·5. (V.41898.)

FIG. 48. Bud which appears to have begun to elongate. ×15. (V.41899.)

Horizon? Rolled block with *Araucarites* twig (V.41920) thought to be Lutetian ; Bracklesham Bay.

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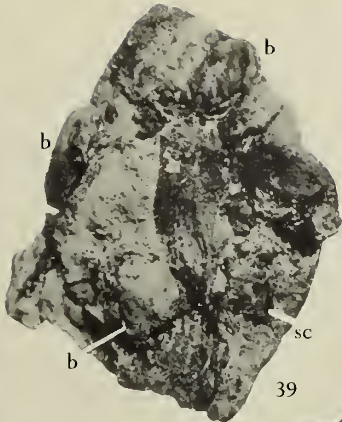

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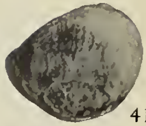

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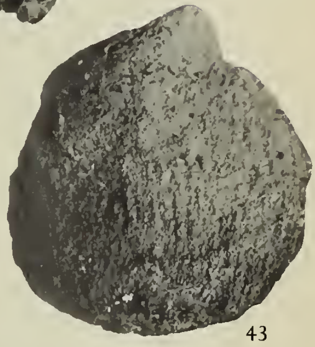

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PLATE 9

Nipa burtini (Brongniart)

Fig. 49. Large carbonaceous fruit, broken transversely and partly encrusted above with pyrites. Attached by pyrites cement at *w* is teredo-bored wood. × 0·8. (V.35722.)

Lutetian, probably from Fisher Bed 7 or 8 ; Bracklesham Bay.

Pinus bowerbanki (Carruthers)

Fig. 50. Cone, imperfect below, showing the narrow apophyses with marked transverse carina. × 0·9. (V.3313.) Bracklesham Bay.

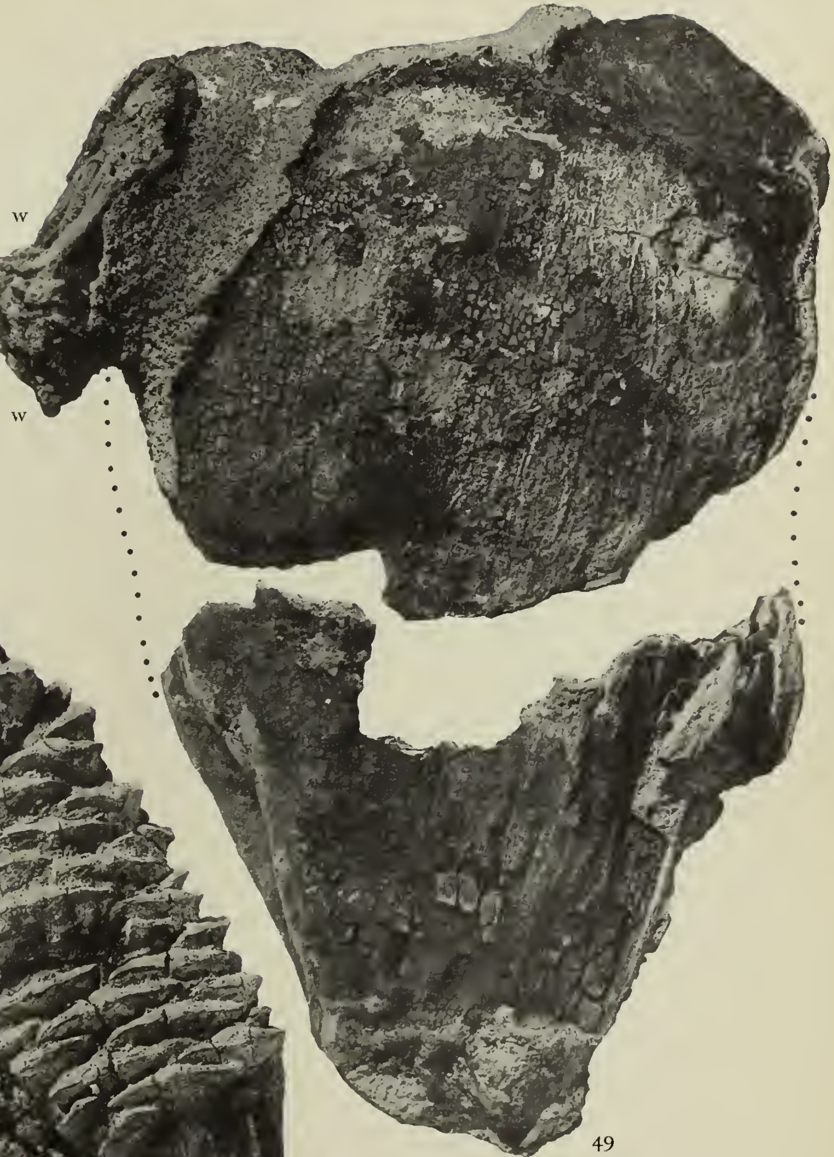

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PLATE 10

Nipa burtini (Brongniart)

FIG. 51. Flattened immature pyritized fruit. $\times 1$. (V.29214.)

FIG. 52. Larger imperfect fruit incomplete at base and apex, showing in profile aperture for germination. Fibres of sarcocarp show on sides. $\times 1$. (V.40260.)

From Fisher Bed 4 (Palate Bed) (Lutetian) ; Bracklesham Bay.

FIG. 53. Minute immature fruit with exocarp preserved embedded in glauconitic ferruginous sand with abundant remains of *Nummulites laevigatus*. $\times 2{\cdot}7$. (V.33732.)

Lutetian, most probably from Fisher Bed 6 ; Bracklesham Bay.

Laurocalyx sp.

FIG. 54. Cupule, slightly distorted so that the rim of the cup is exposed all round. $\times 6{\cdot}5$. (V.41885.)

FIG. 55. Same, opposite side. $\times 6{\cdot}5$.

Loose on shore near Fisher Bed 7 (Lutetian) ; Bracklesham Bay.

Wetherellia dixoni (Carruthers)

FIG. 56. Holotype, fruit, apex. $\times 2$. (40509.)

FIG. 57. Same, base, showing casts of spine bases as light coloured spots. $\times 2$.

FIG. 58. Same fractured longitudinally. On left of axis is a septicidal surface with fibres from the axis ; on the right a locule with impression of distorted pendulous seed. $\times 2{\cdot}8$.

FIG. 59. Same showing oblique dorsiventral compression. Two locules are exposed. Passage of funicles from axis to seeds is shown. Spine bases in thickness of wall appear white through partial decay of pyrites casts. $\times 6{\cdot}5$.

FIG. 60. A seven-carpelled fruit with marked alternating ribs and furrows. Incipient splitting is seen at the base. $\times 2{\cdot}8$. (V.33827.)

FIG. 61. Same apex. Spines represented by pyrites casts of their hollow bases worn down to surface level. $\times 2{\cdot}8$.

FIG. 62. Same side, showing dorsiventral crushing. $\times 2{\cdot}7$.

FIG. 63. Same, split loculicidally. In right locule a minute immature pendulous seed is visible. There is a developed but distorted seed in the left locule. $\times 2{\cdot}7$.

Loose on shore, Bracklesham Bay.

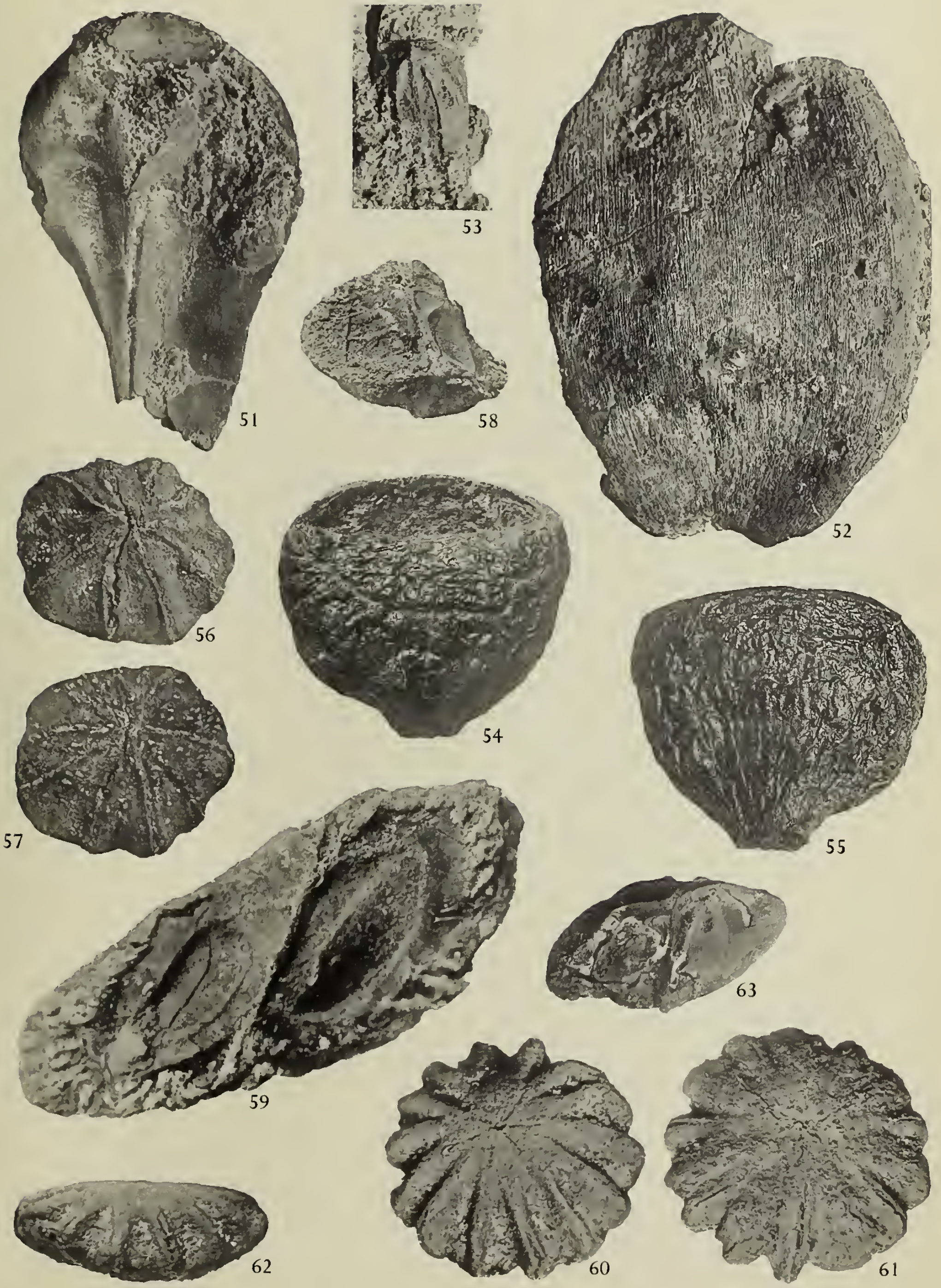
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PLATE 11

Wetherellia dixoni (Carruthers)

Fig. 64. Base of six-carpelled fruit, asymmetrically developed and obliquely compressed. Shows incipient splitting. ×2·8. (V.33825.)

Fig. 65. Same, apex. ×2·8.

Loose on shore, Bracklesham Bay.

Wetherellia sp. (? *W. dixoni* (Carruthers))

Fig. 66. External cast of a coccus. The apex is truncated obliquely by the fracturing of the stone, casts of spines show as small white circular scars. ×2·5. (V.35718.)

Fig. 67. The carbonaceous coccus from the above (similarly truncated), external surface. The longitudinal angle marks the plane of loculicidal dehiscence. ×1·7.

Fig. 68. Same, septicidal surface, showing axial fibres with a branch diverging over the right septicidal surface and itself branching again. ×1·7.

From Cakeham Beds A (Cuisian); opposite West Wittering Beacon.

Wetherellia variabilis Bowerbank

Fig. 69. Much broken coccus, inner septicidal surface showing median line of loculicidal dehiscence. ×2·8. (V.41886.) Fisher Bed 2 (*Turritella* Bed) (Lutetian); Bracklesham.

Carpolithus curryi n. sp.

Fig. 70. Battered pyritized fruit, side. The carpel facing the camera has lost its outer wall so that the placentas, *p*, are exposed, showing attachment scars of numerous seeds. Carpel seen in profile on the left shows impressed through the walls the horizontally attached and oriented seeds within. Carpel on right irregularly broken. × 6·5. (V.41887.)

Fig. 71. Same, apex. Locule on left in Fig. 70 is at *l*. Placentas in broken locule are at *p*. A perianth segment, *s*, is seen extending to the apex of the fruit over the third imperfect locule. ×6·8.

From Fisher Bed 9 (*Ostrea tenera* Bed) (Lutetian); Bracklesham Bay.

Carpolithus sp.

Fig. 72. Valve of a fruit, decaying external surface. ×6·5. (V.41888.)

Fig. 73. Diminished outline drawing to elucidate features now obscured through decay.

From Fisher Bed 21 (Hard Bed) (Auversian); Selsey.

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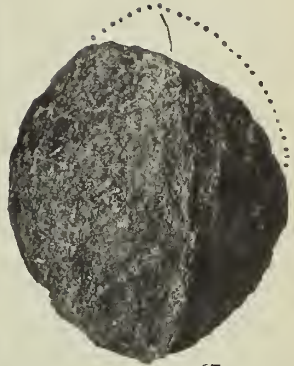

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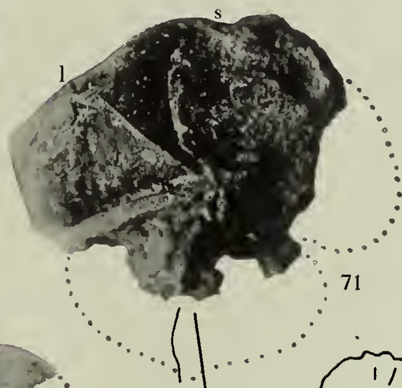

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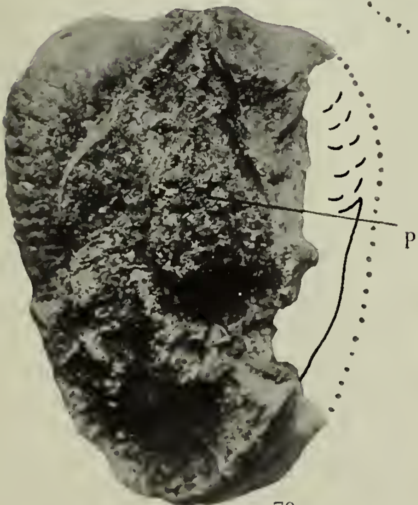

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